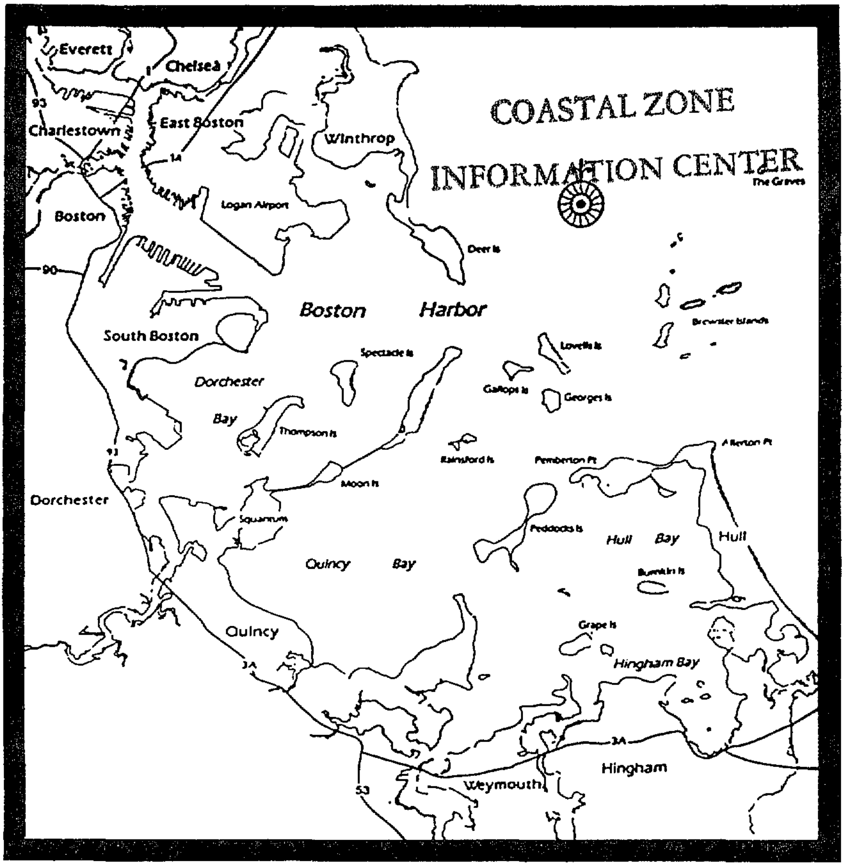
PORTS AND HARBORS: OUR LINK TO THE WATER

Proceedings of the Eleventh International Conference



Boston, Massachusetts
22-26 October 1988

Published by

The Coastal Society
Suite 110
5410 Grosvenor Lane
Bethesda, Maryland 20814

Coastal Society

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Lauriston R. King, Editor

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Changing Land Use Patterns: An Historical Perspective

Hassan J. Ansary, Ph.D.
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Thank you. It is a great pleasure for me to be invited to your annual meeting. I always consider it a pleasure to come to this beautiful city. No North American waterfront has perhaps seen so much evolution and transformation. So the venue for the conference provides a fitting backdrop for this panel.

Before I start, let me give you a quick backgrounder on my organization. Ports Canada is a what we call "Crown Corporation", that is a federal government agency responsible for the administration of 15 Canadian ports. These ports collectively account for more than 50% of Canada's international waterborne trade, and include such major ports as Montreal, Quebec, Halifax, and Vancouver.

So much for a commercial.

The subject of changing land and water use patterns is one that is addressed more and more by port cities around the world. In North America, the pressures felt in large US port cities are not unlike those felt at older European cities.

Similarly, although not on the same scale necessarily, our port cities in Canada are exposed to the same trends.

To get a better appreciation of these trends, we must step back and look at the origin of the city-port interface. I'll present a Canadian perspective. But I'm sure these are equally applicable in this country.

The development of Canadian ports and the urban centers surrounding them have always been closely linked. While the natural harbour provided the geographic location for the initial community settlement, over time, transportation and trade contributed to urban and industrial growth.

The port and the city began as one and the same. Urban waterfronts were the focal point of commerce, concentrating on their commercial maritime function which was the transfer of cargo between the marine and surface modes of transportation. The waterfront was unique in its orientation, with the port exerting the dominant influence on land-use activities not only along the water's edge, but also in the city's central business district.

Throughout the years, advances in marine transportation and cargo handling methods, coupled with fundamental changes in the twentieth century urban lifestyle, both social and industrial, substantially altered the relationship between the port and the city. The changing dynamics of both ports and cities have resulted in a reappraisal of the port and its role in the urban community. In the 1980's, the port no longer has a monopoly on the urban waterfront. In most cases this reassessment of the urban waterfront function is directly related to land, its use, its accessibility and its perception as a tool for economic and social redevelopment. Often, the viable and essential marine transportation function and its impact on the national economy are overlooked, creating tension and even conflict between the port and the urban community.

Conflict arises, amongst other things, from the development and sophistication of marine terminals and the vessels using them. Gone are the wooden finger piers jutting out at right angles from the shoreline. In their place have emerged highly specialized terminals designed to automatically handle containers and bulk cargoes. These container terminals have been isolated along the urban shoreline in major port cities, resulting in a separate identity for the port district from that of the city.

Another closely-related phenomenon is the development of efficient transportation links in the functional port area and its hinterland. Intermodalism is now the key. In Montreal, for example, containers are placed directly on railcars bound for the heartland of America. Unit trains unload grain, coal, sulpher or potash in most major ports. Arterial roads and overpasses have been constructed to handle the ever-increasing truck traffic serving the marine terminals, and have been a major expense and planning concern of ports in Vancouver, Saint John, and St. John's. The effect on the waterfront has been twofold: firstly, the vital commercial role of the port is reinforced in the community. Secondly, structural barriers, both in the physical and psychological sense, are erected between the port and the city. In addition, some obsolete port facilities have adversely affected the port's image and the perception of the waterfront. The relationship between the port and the city, once one of mutual interaction, has become less intimate reflecting, at times, the inevitable conflict.

Changes in the structure and function of the city itself have equally altered that perception. The city core was once the location of manufacturing industries which had a functional relationship with the port. Their raw materials were received through the port and their finished products reached market through the port. For a number of years, though, manufacturing industries have played a diminishing role in the business life of the central city. Industrial firms have migrated away from urban centers, leaving the city core to emerging highrise office towers of business and finance. While there are still many examples of industries located on the waterfront including pulpmills, refineries and fishplants, the urban core of larger port cities is increasingly geared towards the provision of specific services rather than the production of goods.

In comparison with the rest of the city, the port area is often the oldest sector, having been the original site for industrial, commercial and residential uses. As cities changed, through cycles of progress and decline, the urban waterfront was a natural focal point for redevelopment.

There is no particular date when conditions in the port changed. Port development is an evolutionary process. Since the fifties, however, ports have undergone a series of transformations that have affected traditional port-city relations. Two factors, in particular, have produced the most radical changes of all.

Growth in vessel size have also affected water depth requirements. The growing importance of large carriers have favored ports or sections of ports where deep water is available —again, usually away from the urban core.

By the mid-sixties, several new or revised general cargo handling techniques were introduced that further affected the function, operation, and location of ports,. the most notable being containerization. The major effects may be summarized in terms of space requirements which have resulted in greatly increased demand for backup land to efficiently handle movements of cargo.

These trends have accentuated the differences between the old or more city center port areas and the new sections of ports. The extensive land requirements have pushed port development far beyond the confines of the original harbor location. Consequently, a new waterfront constituency has developed, viewing the waterfront as an attractive public resource. Land and water are now defined in terms of access, historical and cultural qualities, residential and recreational potential, and visual aesthetics. In many cities, restoration, renovation, and recreation have become familiar themes as the historical, residential and cultural features of the waterfonrt are physically upgraded and promoted for the benefit of urban residents and tourists alike.

One impact of this changed orientation was that the historical water-related and water-dependent uses of the port were given less consideration as a viable land use, although their continuing economic impact on the city and its inhabitants has seldom been questioned. These changes and their implications ultimately confront port management, albeit at different times and with varying degrees of intensity.

In recognition of change and the importance of the waterfront property for alternative uses, ports have adopted a conciliatory stance, and have conceded significant portions of their land and structures to urban community development. Ports, particularly those in mature urban centers like Boston, have now reconciled themselves with this position and have responded by ensuring that special characteristics of certain waterfront sites have been developed in response to community needs. The Vieux Port projects in the ports of Montreal, Quebec and Trois-Rivieres are prime examples of this new approach. They have provided the urban population with access to these ports and to the St. Lawrence River.

There have been pressures for alternate, non-port-related waterfront developments in the Port of Vancouver. Perhaps the climate, the panoramic setting, and the location of Stanley Park, on the waterfront, have engendered the community with a very personal view and interpretation of the port. Consequently, the waterfront now represents a blending of activities which have perpetuated the human relationship with the ocean. From the public viewing area of the Vanterm container terminal, to the Seabus Terminal, the Canada Place complex, which will be the permanent reminder of Expo 86 and the site of the port's new cruise ship facility, the fundamental role of the port in Canada's transportation network has been maintained.

In Chicoutimi, the relocation of the marine terminal to Grande- Anse, outside the existing urban core, will eliminate the industrial presence of the port in the city and will permit alternate uses of the old terminal area. In Sept-Iles, the construction of the Pointe-Noire terminal, at a significant distance from the city, will encourage heavy industrial development which would not have been compatible with urban life.

Perceptions are changing. There must be a balanced approach towards waterfront development proposals. The role and responsibilities of the port must be understood by all elements of the urban community, not only locally, but also in the regional and national contexts. Canadian port administrators also recognize the intrinsic values and the appreciation which a community places on such a complex resource. Conflicts regarding waterfront jurisdiction, appropriate use, public access and private and public sector participation in project development must be resolved through good planning, sensitivity and an openness for cooperation on all sides.

Our experience in the case of both Montreal and Quebec is that the "Vieux Port" redevelopment projects constituted good faith on the part of our ports and helped build rapport within the community to the benefit of remaining port activities. Today these areas are fully used by the public at no real disadvantage to the ports.

There are only a few specific criteria that I am aware of for the identification and selection of port areas suitable for redevelopment. I will focus on this briefly.

It is important, of course, that the selection of land for redevelopment be based on the principle that the operating efficiency of the port must be maintained or enhanced. Success of the port depends, to a large extent, on convincing all players to consider for redevelopment only those sections of the port which are least viable from a shipping viewpoint. Deciding which properties is not an easy task because no one criterion can adequately represent all the factors that come into play. Also, there are always difficulties in the collection of data.

As mentioned already, vessel size is an important indication of the relative visibility of berth facilities compared with other areas of the port. In addition to a permanent trend toward larger vessels which seek out deep water ports in general, there may be berthing areas which are increasingly less viable within the port, but which the port is reluctant to let go to non-port uses. There may be uncertainty as to their future potential. A survey of vessel volume, tonnage, and frequency of berthage can help build a profile of the port for this purpose. In surveys completed for Canadian ports some years ago, the "Vieux Port" areas show up quite clearly. We were quite certain these areas would have to go.

The age profile of port facilities is also a useful tool in analyzing port redevelopment potentials. The wave of developments using modern port design and construction has usually been in outer-port areas, well beyond the original port limits. Historic properties in the Port of Haslifax, for example, occupy most of the original finger-pier configuration some distance from the new Fairview Terminal. The extensive use of this redeveloped area has added significantly to the tourist potential of the city and has helped build a more harmonious relationship between the port and the city.

In some port redevelopment assessments, these measures have been combined with others such as total revenue generated, expenditures related to repair and maintenance, net financial return, etc. Some consideration has to be given to the specialized use of obsolete port facilities for cruise vessel handling, pleasure craft, military vessels, etc. Depending on the port mandate, some facilities may be retained by the port for lease or operation outside the normal scope of the port.

A document that usually summarizes the considerations I mentioned is a port land-use plan. A port land-use plan is not a master plan, although the two often look alike in many respects. It is a comprehensive inventory of port land holdings and current and projected use of them consistent with present and future forecasts of port activity. Once completed, such a document can be a very effective weapon for the port in two ways: one, it will guide the port in terms of what areas can be made available for alternate uses, if the price is right; and, two, it can be used to fight off—if I can use the term—commercial developers or anybody else, for that matter, who might be eyeing waterfront properties without due consideration to their indigenous use or importance to the overall port operations.

Naturally then, the outcome of any redevelopment assessment will vary depending on the mandate of the port authority. If the role of the port has already shifted from commercial marine to some other status, it may continue to be the operator of the proposed redevelopment area.

We at Ports Canada are determined to continue to play our vital role in reconciling the diverging pressures on waterfront lands for cultural values, on the one hand, and economic development, on the other.

Thank you.

REVITALIZATION OF THE MASSACHUSETTS WATERFRONT THROUGH THE CHAPTER 91 PROCESS AND THE PUBLIC/PRIVATE PARTNERSHIP

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Introduction

Over the last five years, Massachusetts has realized unprecedented levels of growth and development along the waterfront areas of its ports and harbors. It is estimated that over $5 billion dollars will be spent over the next decade on various types of waterfront development projects and nearly one- half of this amount will be spent on developments along Boston's Inner Harbor. The recent surge in demand for new development along the Massachusetts coastline has resulted in the reconstruction and revitalization of existing under-utilized and deteriorated waterfront sites, particularly in urban harborfront areas.

The state's Chapter 91 Waterways Regulation Program plays a central role in regulating the type and extent of waterfront development in its coastal tidelands. The Chapter 91 process protects public trust interests in both filled and tide-flowed tidelands of the Commonwealth. The public/private partnership is established by the Chapter 91 process through a state licensing agreement which allows the waterfront developer to use public tidelands for private economic gain. The developer, however, agrees to construct and maintain certain facilities of public accommodation within new buildings, public access to and along the site's waterfront, and water-dependent uses; all of which will serve to promote and enhance public use and enjoyment of the harborfront area.

The practical result of the state Chapter 91 regulatory process (and the consequent establishment of the public/private partnership) is that it provides new opportunities for public use and enjoyment of waterfront areas where none had previously existed. More importantly, these public use benefits are constructed and maintained by the waterfront developer at no cost to the public as part of the Chapter 91 authorization to build in tidelands.

The Chapter 91 Tidelands Statute and Waterways Licenses

Massachusetts General Laws Chapter 91 and its regulations serve to protect the public trust rights of the Commonwealth in coastal tidelands. Administration of the law requires a state agency to regulate and license any use or construction in the state's coastal tidelands and waterways. The state has exercised its public trust responsibilities under Chapter 91 since 1866 through the issuance of regulatory approvals called Waterways Licenses. Over 12,000 Waterways Licenses have been issued by the state under Chapter 91 jurisdiction since its enactment, most of which are still in full force and effect.

The state agency that currently administers the Chapter 91 Tidelands Licensing process is the Department of Environmental Quality Engineering (DEQE) through their Waterways Regulation Program. DEQE reviews applications for the placement of any new structures or fill, any changes in use or structural alterations of previously licensed structures or fill, or dredging in state tidelands below the High Water Mark.

If the application for work in tidelands is approved by DEQE, the agency issues a Waterways License which contains License documents, detailed License Plans, and any special conditions of licensing approval for the proposed work. The Licensee must comply with the terms and conditions of the Waterways License in order for it to remain valid. Currently, Waterways Licenses are issued without any expiration date, however, term licenses are being adopted by DEQE.

Chapter 91 Regulatory Jurisdiction in Tidelands

Although private ownership rights extend to the Low Water Mark in Massachusetts, the public trust rights of fishing, fowling and navigation in coastal tidelands begins at the High Water Mark. Hence, Chapter 91 jurisdiction and the state's public trust responsibilities have traditionally extended from the High Water Mark out to the state's three mile offshore limit of jurisdiction.

There are two principal types of tidelands in Massachusetts:

The intertidal area from the Mean High Water shoreline to the Mean Low Water Springs shoreline (average of the lowest Low Waters over 19 years) is called "*Private Tidelands*". This tideland area is statutorily defined as: " Tidelands held by private party subject to a condition subsequent of the public for the purpose of navigation, free fishing and fowling and of passing freely over and through the water."

The sub-tidal area and submerged lands from the Mean Low Water Springs shoreline to the state's 3-mile offshore limit are called "*Commonwealth Tidelands*". The state exercises proprietary rights in Commonwealth Tidelands. This area of state land is statutorily defined as: "Tidelands held by the commonwealth in trust for the benefit of the public or held by another party by license or grant of the commonwealth subject to an express or implied condition subsequent that it be used for a proper public purpose."

Recent Statutory Amendments to Chapter 91

In 1983 and 1986, the existing Chapter 91 General Laws underwent significant legislative review and certain sections were amended to reflect the current reaffirmation of the state's public trust responsibilities in its coastal tidelands. One of the most significant amendments to the tidelands statute was that the state's definition of the term "*Tidelands*" was broadened to include all *filled former submerged lands below the High Water Mark*. This meant that DEQE's area of regulatory jurisdiction was expanded to include not only presently tide-flowed tidelands, but also former natural tideland areas that have been historically filled by man since the Colonial Ordinance of 1647 (the origin of public trust in Massachusetts).

Another important amendment to the Chapter 91 statute was that any change in use or structural alteration of previously licensed structures or fill in tidelands, or new construction, requires re-authorization by DEQE. This is to ensure that any reuse of tidelands will be consistent with the new state policies. For example, changing the use and reconstructing an old deteriorated pier structure in tidelands from its previous maritime-related use to a mixed-use waterfront development requires the issuance of a new Waterways License.

Other amendments to the existing statute also required new substantive standards and procedural requirements that must be complied with in order to receive a Waterways License. New substantive standards require that DEQE can only approve water- dependent uses in tidelands. Any nonwater-dependent or other use of Commonwealth Tidelands must serve a "proper public purpose" in addition to providing water-dependent uses. A nonwater-dependent use of filled or tide-flowed tidelands (e.g. a waterfront hotel) can only be licensed if it meets DEQE's Proper Public Purpose standards and is determined to be consistent with the coastal development policies of the Massachusetts Coastal Zone Management Office. The new procedural requirements for Waterways Licensing reinforced the traditional Home Rule form of government by soliciting local public review and comment, and requiring municipal approval of any proposed use of its tideland areas prior to state authorization.

The practical result of these statutory changes for use and development of tideland areas, particularly the formal expansion of Chapter 91 jurisdiction to the historically filled tidelands, is that DEQE must now assume the added role of a waterfront land- use regulator while still maintaining its traditional role of regulating marine-related construction in coastal waterways.

The state's new responsibility to actively regulate the use and development of its coastal waterfront land areas within Chapter 91 jurisdiction has created a new partner in Massachusetts' waterfront development boom. In recognizing that revitalization of urban waterfront areas cannot be fully realized by public funding alone, the state attempts to establish a partnership agreement with the waterfront developer through the Chapter 91 Waterways License. This state licensing agreement allows the construction of new public and private uses in tidelands to fuel the revitalization of deteriorated and under-utilized waterfront areas that might otherwise remain in that condition.

In conjunction with other local and state agencies, DEQE negotiates the licensing agreement with the waterfront developer that authorizes new development in public tidelands for private economic gain, provided that the developer agrees to construct and maintain certain water-related and water-dependent uses available for use by the general public. The developer must include facilities of public accommodation (e.g.restaurants, cultural exhibits, and commercial retail uses) within the private development area that will encourage both public and private uses of the waterfront site. In addition, public access, open-space areas and water-dependent use facilities linking the land and the water at the site must also be constructed and maintained by the developer.

The Chapter 91 Licensing Process and the Public/Private Partnership

The public/private partnership is initiated by the Chapter 91 regulatory process when either a change the use or structural alteration of previously filled or wharfed tideland areas is proposed to accommodate a new development on the waterfront. Usually, this tideland area was filled or wharfed under previous Chapter 91 Waterways Licenses issued throughout the history of the site's maritime-related uses. Many of these waterfront sites have been vacant or under-utilized for decades. The timber wharfs, bulkheads and filled areas along the waterfront are typically in deteriorated and unsafe condition with limited or no public use and access.

The developer proposes to combine a program of both public and private uses that justify the economic investment for redevelopment. The programming for private development typically includes a mix of office, residential and commercial retail uses. The programming for public use amenities typically include public waterfront access and open-space areas, water-dependent uses (usually a recreational or commercial boating facility), and various types of facilities of public accommodation which will create a locus of public activity and destination value for the waterfront site. The developer is also required to manage and operate these public use amenities or is required to integrate the waterfront site with adjacent public waterfront parks or boating facilities adjacent to the site.

Chapter 91 public purpose standards require that the proposed waterfront development must be consistent with the planning and zoning requirements of the municipality in which the development is to occur. To ensure this, the regulatory review process requires public notices, solicits public review and comment, and municipal planning and zoning approvals of the proposed project prior to state authorization. If a nonwater-dependent use of tidelands is proposed, or the state determines that further public review is required, DEQE will hold a public hearing in the affected municipality.

Once the public review process is complete, DEQE commences negotiations with the waterfront developer to determine the type and extent of public benefits that must be incorporated into the waterfront development to receive Chapter 91 authorization. Presently, the state's minimum requirements for facilities of public accommodation to be included in new development in tidelands consist of: full public access to and along the water's edge of the site; landscaped waterfront open-space area; at least one water-dependent use; and the inclusion of public use amenities within waterfront buildings such as retail space, hotels, restaurants, museums or cultural exhibits.

At the conclusion of the Chapter 91 review and negotiation process, the state and the developer agree on the type and location of the public use amenities to be incorporated into the waterfront development that are necessary to meet the public trust standards for these tidelands. DEQE issues a Chapter 91 Waterways License approving the development which includes specific licensing plans that are recorded with the property title documents. The license also includes special conditions of issuance that requires the developer to construct and maintain the approved public use amenities, and in most cases manage these facilities, at no cost to the public over the term of the license.

Examples of Waterfront Development Projects Approved Under Chapter 91

Rowes Wharf

One example of a mixed-use waterfront development that serves as a prototype of the public/private partnership through the Chapter 91 process is Rowes Wharf. Rowes Wharf is located in the Downtown Waterfront District of Boston in the Inner Harbor and was originally constructed by the merchant, John Rowe, in the early 1760's to serve as the location of Mr. Rowe's maritime trading and fishing businesses. The wharf continued to serve a variety of maritime-related uses throughout its history. The existing wharf structures began to show signs of decay by the 1930's and only portions of the wharf were safe for use as a ferry dock in the mid-1980's. The Beacon Companies, a local real-estate developer, was designated by the City of Boston to re-develope the deteriorated wharf structures into a mixed-use waterfront development. This development was to include a mix of commercial, residential and water-dependent uses.

Since the proposed redevelopment of Rowes Wharf was located in commonwealth tidelands of Boston Harbor and constituted a structural alteration and change in use of the existing wharfs and filled area, it required state regulatory review and approval under Chapter 91. At the conclusion of the Chapter 91 regulatory review and approval process, the site development included a successful mix of public and private uses. This mix of uses allowed the developer to justify the economics of its redevelopment while at the same time provide new and substantial public benefits within the overall development area, particularly at and along the water's edge of the site. These public benefits included public access, water-dependent uses and facilities of public accommodation within the new buildings.

Demolition of the old wharves and construction of the new development at Rowes Wharf commenced in 1985 and was completed in 1988. The approved non-water-dependent uses constructed in three new buildings at the site include commercial office and retail space, residential condominium units, below-grade parking, and a 230-room hotel in three new buildings, The water-related and water-dependent uses at the site include a new public Ferry terminal and pavilion, public walkways, courtyards and promenades leading to and along the water's edge, a new public dock landing and 40-slip marina, commuter and excursion boat docking and service, and a Water Shuttle Service to Logan Airport.

Over 60% of Rowes Wharf is publicly accessible. The new ferry terminal and pavilion service over 3,000 daily commuters. Prior to construction of the ferry terminal and docks, there were approximately 20,000 water transportation passengers per year landing at Rowes Wharf. It is expected that ridership levels will climb to over 1,000,000 passengers in 1988. When the developer instituted a Water Shuttle service From Rowes Wharf to Logan Airport, it was expected to generate 80,000 passengers in its first year of operation; it actually generated more than 150,000. The Chapter 91 license also required that the public Ferry Terminal and pavilion be managed and operated by a tripartite Operations Board made-up of DEQE, the City of Boston and the Developer to reinforce the spirit of the Public\Private Partnership agreement.

The Rowes Wharf development opened to rave public reviews and is widely received as a model waterfront development for Boston Harbor. The public Ferry Terminal and water transportation services using Rowes Wharf continue to grow in ridership levels; exceeding all expectations of demand. Integration of hotel, office and residential uses within the new buildings has created a year-round locus of public activity at this waterfront site and has not created significant user conflicts with the mix of water- side uses.

The Schrafft Center

The Schrafft Center is another example of the Chapter 91 Public/Private partnership at work. The Schrafft Center is a newly renovated commercial facility located on filled tidelands of the Mystic River in the Charlestown section of Boston. This waterfront site was the location of the former Schrafft Candy Factory that made specialty candies and other confections from the early 1920's to the early 1980's. The candy factory ceased operation and vacated the existing buildings at the site in 1982.

The Flatley Company, a local real-estate developer, purchased the unused waterfront site and vacant buildings in 1984, and proposed to renovate and expand the existing buildings into a mixed-use commercial office and light manufacturing facility serving the Massachusetts High-Tech industry. The development objective was two-fold: to attract the High-Tech industry to create jobs and economic revenue, and to open the site to public use and access for the Charlestown community.

Nearly all of the site's 15-acre area consists of filled and presently tide-flowed tidelands of the Mystic River. Hence, the proposed change in use and structural alteration of the filled tidelands to accommodate the new waterfront development required Chapter 91 regulatory review and approval by DEQE. At the conclusion of the Chapter 91 process, the development proposal was approved with conditions that the developer construct, maintain and manage public access and water-dependent use facilities at the site that would be available for use by the general public.

The package of public benefits derived from the Chapter 91 process include a landscaped waterfront boardwalk along the water's edge that connects the site with an adjacent city playground, a public access pier in the Mystic River that provides docking for a community sailing club and serves as a Water Shuttle landing with connections to the Downtown Waterfront, a public boat launching ramp into the Mystic River and parking for boat trailers, and dedicated public parking areas for users of the site's public facilities. The developer also agreed to create, staff and manage a community sailing club at the site for use at no cost by Charlestown youths and provide 24- hour site security for these facilities.

There are many more similar types of mixed-use waterfront developments planned for construction along the Massachusetts coastline within the next decade, some of which have been approved and are under construction, while others are still in the planning and design stages. These projects will be revitalizing existing under-utilized waterfront areas, provide new commercial and recreational water-dependent uses and create new opportunities for public use and access of our harborfront areas.

Conclusions

The new Chapter 91 Tidelands Licensing process provides a critical mechanism for the public sector's role in ensuring that the public interest is being served by new waterfront development in tidelands along the harborfront areas of the Massachusetts coast. The collaboration between the public and private sector to reconstruct and revitalize under-utilized waterfront areas has created valuable results. Similar results will be possible throughout the Commonwealth's waterfront as these public/private partnerships continue. These partnerships enhance both parties: the public sector establishes guidelines and regulations that protect the public interest, while the private sector is allowed to do what they do best - create new economic worth for the community and provide new opportunities for use and enjoyment of our valuable waterfront resources.

CHANGES IN THE URBAN WATERFRONT IN CALIFORNIA: Is the Working Waterfront Still Working?

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INTRODUCTION

Almost every large city with a waterfront has a waterfront revitalization program planned or operating, as do many smaller cities. From Baltimore to Seattle, from Gloucester to Morro Bay, local governments and private developers are rebuilding the troubled, often forgotten neighborhoods which nurtured the original development.

In California, as well as the rest of the nation, the effort is underway to reclaim deteriorated and abandoned waterfront land for other uses. The decline of many ports and concentration of port-related uses in a few large ports have made sizable amounts of land available for other purposes and have presented many cities with unparalleled opportunities to redesign their waterfronts. This paper takes a look at some cities in California undergoing this process and reviews their accomplishments. It also attempts to describe some of the problems faced by communities seeking to revive their waterfronts. Finally, an attempt will be made to evaluate California's experience in an effort to draw some conclusions as to whether the process is providing viable or sterile waterfronts.

The Waterfront

The term *waterfront* obviously includes the shoreline with its piers, wharves, and immediate onshore environs. But the waterfront also includes an area behind the shoreline proper that may be two or three city blocks deep, and which contains and can contain land uses that are linked to waterfront activities housed right on the shoreline. Everything from warehouses and marine suppliers to visitor-serving commercial uses and public institutions fit readily into this area. Gordon Cullen, in "The Concise Township," described the waterfront atmosphere of the fishing-boat community of Brixham on England's south coast:

> It is combined social and working centre; visitors promenade the quays and treat the fish market as a free entertainment; coloured sails and flags and the whirling wings of seagulls combine to create an effect—that of a busy industrial scene permanently en fete.

The operative term here is "busy industrial scene permanently en fete," a scene of commonplace but colorful work, perpetually in celebration. Cullen has described the quality that has traditionally made urban waterfronts such interesting, pungent environments, such a lure to people of all ages and conditions. Unfortunately, with the same phrase he also has described exactly those qualities now being sanitized out of many waterfronts by the process of prettification-for-profit.

The Decline of a Waterfront—San Francisco*

Nowhere is this lamentable process so evident as along the San Francisco waterfront. Where once there was an incredibly active scene of shipping, trade, commerce, boat building and repair, of fishing, seafood processing, and all the shipment systems for these activities, today there remain only pockets of the former life, ghettos of real-life water-related uses. The repair yards and docks of the southern waterfront are still there, and a diminished Fisherman's Wharf, where commercial fishermen continue to haul in their catch backstage, as it were, of the tourist show.

The bayshore is increasingly bedizened with tourist traps, tangential open spaces, hotels and motels, and with inappropriate commercial and institutional uses such as law offices, ad agencies, and the San Francisco Eye Institute. Wharves and piers formerly a bustle with shipping and fishing pursuits that created what Cullen called a "combined social and working centre" have been replaced in many places with a travesty of a real-life waterfront, a public relations marketing figment of a disappearing reality.

Container shipping and automation began to take hold in the Bay Area during the 1960s, but the City and the Port of San Francisco failed to seize their potential and challenges. Consequently, for more than two decades, shipping and cargo steadily drained away to Oakland, Los Angeles, and the Northwest port cities. While automation and containerization produce, perhaps, a less colorful port environment than 19th century tars singing sea chanties or Harry Bridges leading his longshoremen against the shipping magnates, still a working seaport can be a far more interesting tourist lure than the evanescence of souvenir shops and wax museums.

The misjudgments of the '60s and '70s are barely beginning to be readjusted for the '90s, conceivably too late with too little. A container facility has been proposed for Piers 30-31, where the great Matson Navigation Co. floated a flotilla of 24 or so freighters between the two world wars. Pier 50 near China Basin also has been proposed for container shipping. "Love Boat" type cruise ships still tie up on the beleaguered north waterfront, close to the Fisherman's Wharf, and produce a $70-million-a-year business. Indeed, a recent report by the Port of San Francisco warns of losses to other port cities unless a new expansion program is undertaken very soon. There will be little room for this expansion if the waterfront is increasingly occupied by non- maritime uses. San Francisco has negotiated with Israeli and Chinese cargo shippers for their use of Piers 94-96 further south along the Bay between Islais Creek and India Basin, near the industrial-military uses of Hunters Point.

This is in laudable contrast to the continuing push by developers, their design and planning consultants, and such groups as the San Francisco Planning and Urban Research Association (SPUR) for a waterfront dedicated principally to shops, offices, cafes and restaurants, tourist lures, and some housing, along, no doubt, with the ubiquitous urban decoration of information kiosks, twinkling designer lights and beguiling graphics, mini-parks, stalls for croissant and T-shirt sales, photo-oppor-

**Portions of this section are taken directly from an excellent article by Jim Burns entitled "Visions of a Vital Waterfront" (California Waterfront Age, Vol 3, No.2 State Coastal Conservancy, Oakland, 1987, pp. 20-30). In that article, Mr. Burns goes on to describe the mostly ineffectual efforts by the Port and City of San Francisco and the people of San Francisco to preserve the working waterfront.*

tunity sites for tourists, and places for performing mimes, all of which are more appropriate to Market Street, Union Square or Columbus Avenue than to a marine environment.

Smaller Cities

The waterfronts of smaller cities in California, unlike San Francisco, are often characterized by little available land for redevelopment, deteriorated public facilities, abandoned or underused public and private facilities, and inadequate or even non-existent public access to the water's edge. The scale of development is usually small, so that residential and other uses are mixed in with or very close to the main "working waterfront" activity. Small cities typically had a single primary economic activity, fishing, for example, or tourism and therefore are more vulnerable to impacts resulting from economic changes.

There is often a curious lack of public or civic imagination concerning the opportunities to revive and enhance these small city waterfronts. I believe this response is partially related to a mistrust of urban density, heterogeneity, and activity. This mistrust takes many forms, including a preference for "coarse-grained" zoning and separation of uses, self-contained shopping malls, neatly manicured if antiseptic parks, lack of sidewalk activity, and, above all, no loitering. Many small cities which possess restorable waterfronts began as or grew into major centers for fishing (Eureka, Morro Bay), tourism (Oceanside), or other commercial or recreational activities. A sense of its history can provide a solid grounding for a community's restoration effort.

The two main values of the waterfront, water- or shore-related industries and public use, provide a healthy focus for restoration in small cities. The pervasive "community orientation" found in small communities is a potentially powerful asset in assuring that a restored waterfront in not a sterile or private one. For in these smaller waterfront areas, one very often finds remnants of the vitality, variety, intimacy, and informality that marked them in earlier days. The challenge in such situations is to demonstrate that economic development and environmental enhancement for the public's benefit can complement each other and are not antagonistic. The small size and scale of development and relative simplicity of small city waterfronts may also provide a great opportunity for enhancement, not replacement. Scarce financial resources can be concentrated on limited possibilities. Physically, such sites frequently have particular scenic qualities associated with location and development scale that call for a few fairly obvious design solutions to retain a recognizable and desirable waterfront character and to promote public access to the shoreline without conflicting with marine industry. There are sometimes opportunities for mixing economic development and public access through grade or level separations or other "controlled access" approaches. Behind such a public and marine-oriented waterfront edge, a good deal of other development might be permissible without endangering waterfront use and atmosphere.

1. Benicia

The historic community of Benicia lies on the shores of the Straits of Carquinez, the waterway linking San Pablo Bay and the Sacramento and San Joaquin Rivers. Established just prior to the Gold Rush as an ostensible rival to San Francisco, Benicia was California's capital for a year from 1853 to 1854.

The departure of the capital, and the rapid rise of San Francisco 27 miles to the south as an urban, industrial, and shipping center, left Benicia with the reputation of a city of dashed expectations. But the failure to develop into a metropolis looks, in retrospect, like a boon: today Benicia is a thriving small city with 19th century ambience and unique charm.

Yet there is another far less obvious aspect of Benicia's heritage. Just off the waterfront at the foot of West 12th Street, and visible only at low tide, are the remains of the Matthew Turner/James Robertson Shipyard, which launched 165 vessels between 1883 and 1903. It was the center of Pacific coast wooden shipbuilding and one of the most significant shipyards in the United States in the late 19th and 20th centuries. Now it is a city waterfront park, one of California's newest state historical landmarks, and a candidate for listing on the prestigious National Register of Historic Places. The city is working with the National Park Service, the State Coastal conservancy, the Benicia Historical Society, and with private citizens and volunteers to create a unique historical park, archaeological preserve, and recreational facility.

The Matthew Turner Shipyard Park is a precedent for sensitive waterfront recreational development because it is cognizant of a maritime past that is not always tangible, but is of interest to the public. The survival, preservation, enhancement, interpretation, and public use of a nationally significant historic site and its archaeological remains is unusual at a time of active urban waterfront development. As citizens continue to volunteer to bring about the project's fruition, its value will continue to grow.

2. Point Arena

Point Arena is a tiny incorporated city (pop. 450) on California's north coast. One mile west of town, at the mouth of Point Arena Creek lies Arena Cove. Prior to the winter of 1983 the cove supported a wharf, batik shop, fishing equipment store, fish packing house, boathouse, skiff rentals, and a cafe. These facilities and services attracted commercial and sport fishing boats as well sport divers, all contributing to the overall economic activity of Point Arena. The nearest ports of refuge are Noyo Harbor in Fort Bragg, to the north, and Spud Point in Bodega Bay, to the south. Each is a twelve-hour run from Point Arena.

In January 1983, storm waves ravaged the cove, destroying the wharf and fishing packing houses and severely damaging the cafe and boathouse. No commercial boats could be launched from Point Arena that year, and no fish were landed. Local support business such as restaurants, hotels, and campsites in the area suffered. During the following two years, at least 35 businesses either relocated or closed. The devastation caused by the storm, coupled with the decline of the area's logging industry, proved extremely debilitating to the local economy.

To redress this state of affairs, consensus grew in the community that the cove should be developed into a full-scale commercial fishing and recreational port and harbor. The city of Point Arena was not eager to be the lead agency in administering a port district, so citizens formed the Arena Port Commission, hoping to create a legal entity that could contract for public agency funding.

The commission set in motion the procedures for the formation of an official port district. By early 1984 it was developing a phased facilities restoration for the cove.

The city located potential state and federal funding sources for the planned construction. These included the State Coastal Conservancy, California Department of Boating and Waterways, the State Wildlife Conservation Board, the Army

Corps of Engineers, and the U.S. Economic Development Administration. These agencies' regulations and policies, however, required that before a final funding commitment was made, the city acquire the necessary land.

The City of Point Arena lacked the financial resources for such a purchase. However, the State Coastal Conservancy, an agency set up in part to fund waterfront restoration projects such as this, was able to provide gap funding, thereby enabling the project to go ahead. It approved grants for the acquisition of land necessary for the permanent reconstruction of the fishing pier/boat launch facility. This initial boost to one element of a larger waterfront plan catalyzed an economic revival in the community.

The restoration of the cove highlights the importance of any agency like the Conservancy, which can offer expert advice and critical "gap" funding to small cities. The economy of the Point Arena area was tremendously dependent upon the coastal uses of the cove. Yet the city was completely unable to take on even the beginning aspects of the restoration effort without outside assistance. By providing initial funding and helping Point Arena realize one highly visible and immediately useful element of its larger plan, the Conservancy generated the impetus for further self-help and development in the area. Before the wharf was rebuilt, many local residents viewed Point Arena as a dying community. With Conservancy funding and some technical help, a turnaround was accomplished.

3. Santa Barbara

The city of Santa Barbara (pop. 77,000) had a major economic/public access conflict regarding the future of its city- owned Stearns Wharf. The wharf was an historic and much-lived public structure that had evolved into the major regional recreational facility, but had been closed for several years because of severe fire damage and deterioration. With Coastal Conservancy assistance, the apparent conflict between maximum public access on the pier versus a self-supporting public enterprise was resolved. This accommodation arose from a regulatory stalemate in which the city and its developer claimed that the pier could not be rebuilt without a threefold increase in the amount of space devoted to revenue-generating development. The solution was a multiple-source funding arrangement, including the use of a little-known federal loan program (since defunded) arranged for by the Conservancy, as well as city and Conservancy funds. This enabled redesign of Stearns' uses to leave three-fourths of the deck area available for free public access. In effect, the existing development "footprint" on the pier was rebuilt. The wharf reopened in October 1981, and in its first year of operation the wildly successful restoration grossed over one million dollars and was swarmed over by thousands of people who welcomed back "their" wharf.

4. Eureka

A final example of a small city attempting to come to grips with its waterfront problems is the north coast of Eureka (pop. 25,000). In contrast to the previous examples, Eureka has suffered the severe and successive impacts of major adverse economic shifts in its two primary waterfront-related industries, commercial fishing and timber, over which it has had little or no control. Eureka has attempted to take advantage of its architectural heritage through a program restoring the old central neighborhood immediately behind its extensive if deteriorating waterfront. Attractive as it is, this effort has not yet generated the kind of significant economic revival hoped for by the city. The city's damp, gray climate and disadvantageous location have limited its tourist and convention appeal. Moreover, there exists a local controversy concerning the existence of degraded or threatened wetlands along portions of the city's waterfront. These marshy areas and their adjacent uplands comprise remnants of the original Humboldt Bay shoreline that existed before European settlement. They are viewed by some as impediments to needed development, even while existing redevelopable areas remain idle.

Recently, the city apparently modified its emphasis on tourism and the kind of wishful convention-center development that has become almost a fashion for many coastal communities seeking an economic shot in the arm. Attempts are now being made to attract coastal-dependant industries that can make ready use of underused waterfront lands, even as the city continues to try various approaches to conserving its dwindling but unique wetland inventory compatible with its development needs. Stimulation of opportunities for other industrial growth, based on local strengths and advantages, may well prove more advantageous for Eureka than the tourist-oriented restorations being attempted farther south.

Conclusion

The waterfront redevelopment phenomenon reflects both private developers' needs to maximize economic return and a widespread and deepseated aversion to the diversity and "creative disorder" which historically characterized urban waterfronts. Meanwhile, many cities continue to grapple with the impacts of external industrial change on their waterfront industries, as well as on their own unique community outlooks.

Urban waterfronts—whether on rivers, lakes, estuaries, or coastlines—face serious challenges in surviving economic and social change. Yet they also possess special opportunities for revitalization. With increasing metropolitan and small city growth, overuse of national parks, and other pressures on existing recreational facilities, redeveloping these urban waterfronts will gain in importance.

URBAN WATERFRONT DESIGN PRINCIPLES*

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INTRODUCTION

Regrettably, where people have settled on the coast, habitations, work places, and leisure places have too often ignored the fundamental aspects of the coastal environment. The result has been architecture and urban development that all too frequently has not harmonized with its unique surroundings. The visual clutter and ecological insensitivity that characterize much development along America's coastlines is characterized by incongruity with site and surroundings.

Of particular concern are the urban edges, where cities meet the sea. In California, over two-thirds of the state's population resides in two coastal urban centers: the San Francisco Bay Area and the Los Angeles Basin. In these and other coastal urban areas, the competition for waterfront space and the need for public access to the shore exacerbate the problems of past haphazard development and present deterioration. The problems of the urban waterfront are matched by its potential—in the urban coastal environment, the varied physical context and multiplicity of needs make design a challenge and an opportunity. In contrast, design for undeveloped rural areas on the coast must take into account fewer but more, obvious considerations, such as the impact of development on views, sensitive habits, landforms, and traffic circulation.

This paper will discuss some principles of urban coastal design that will hopefully guide architects, designers and planners through the process of preparing development plans. The principles are general; they are meant as building blocks. California's efforts in coastal design development are discussed where relevant, reflecting the author's experience.

California's Coastal Program

For the past fourteen years, the State of California has regulated design and development in the coastal zone, a band of land that stretches from Oregon to Mexico and extends from a few city blocks inland to as much as five miles from the shore. In 1972, California's voters approved a citizen-initiated referendum, Proposition 20, intended to protect the state's coastal resources. In 1976, Proposition 20 led to the adoption by the Legislature of a program for the protection and enhancement of the California coast. The creation of an agency to plan and regulate coastal development, the Coastal Commission, and one to restore coastal resources, the Coastal Conservancy, were the two most prominent features of that program. In 1981 the Legislature expanded that program by adopting the "urban Waterfront Act of 1981" and authorizing the State Coastal Conservancy to undertake and fund

**Portions of this paper are taken from: Petrillo, Joseph E., and Peter Grenell, The Urban Edge, Where the City Meets the Sea, California State Coastal Conservancy and William Kaufmann, Inc., Los Altos, California, 1985.*

restoration of the state's urban waterfronts and "to promote excellence of design and [to] ...stimulate projects which exhibit innovation in sensitively integrating man-made features into the natural coastal environment." In 1983 the Legislature further confirmed the state's commitment to waterfront restoration by authorizing the sale of $650 million in bonds to fund the program. As a result of this intensive involvement in its coastline, California has developed an approach to urban waterfront design that provides some general insights into the fundamental design criteria for urbanized coastal areas.

California's coastal program has attempted to encourage and, where necessary, require designs which take into account a proposed development's immediate and surrounding environmental characteristics. Too often, designers of coastal projects have concentrated almost exclusively on the structures themselves and their component parts, and have not given adequate thought to protection of scenic values, ecologically sensitive areas, and public access to the shoreline. The Coastal Commission has tried, therefore, to provide design parameters, an "envelope" based on the Coastal Act within which the structure must fit.

Urban Waterfront Design Criteria.

From California's experience with urban waterfront development certain design criteria become evident.

Almost without exception, sound coastal design is reflected in development which appears to fit its setting. This does not always mean that design must be hidden from view. Design for human activity can enhance a site, adding to the natural setting. But enhancement is a quality that is subject to opinion and thus difficult to treat by regulation. What one person considers an enhancement, another may consider obtrusive.

Development design along the coast should not consider a structure's design in isolation. The primary concern should be the suitability of the design for the environment—a view of architecture that seems more in keeping with the oriental tradition of seeking harmony with nature than with the western tradition, of imposing a human type of order upon the natural world. In the western tradition architects create a design by arranging a set of design elements to harmonize with each other, though not always with their natural setting.

For this reason, the aim of any coastal program should be to subordinate new construction in rural areas to its surroundings and to require new construction on urban waterfronts to be compatible with the type and scale of existing structures and uses. Development should also encourage public use and enjoyment of the coast, and wherever possible, require new development to preserve and encourage traditional coastal activities—fishing, shipping, water-oriented recreation, and other activities that are dependent on a coastal location. The Coastal Act's designation of these activities as priority uses preserves not only the aesthetic diversity of the waterfront but its economic diversity as well.

Five Principles of Urban Waterfront Design

The key to success in urban waterfront redevelopment projects lies, in my opinion, in adherence to the following simple design principles:

1. Public access must be a central feature. Public use areas should be made invit-

ing in terms of size and location. Structures should be set back from public areas to avoid any sense of intrusion. Places to sit, rest, eat, and drink should be provided adjacent to and generally inland of the public area. Access areas should be linked wherever possible. Planners must be aware that if public access is treated merely as a legal requirement, which can be satisfied by providing an uninviting walkway that winds through an intimidatingly large project, the concept of public access has no impact.

2. Major public views of the coast must be protected by design. This has both public and private components. The public component requires that views of the water from public access areas should be unobstructed. If existing views of the water from a public roadway are unavoidably obstructed by development then the development should have alternative viewing areas in the design plan. Also, view corridors from public areas to major points of interest should be provided. As for the private component, wherever practical, and where it would not conflict with public views, the development should allow inland buildings a view of the waterfront. For example, in Battery Park City in New York the buildings were located in such a way that a view corridor was preserved for buildings inland of the site that would normally have had their views blocked. This quite simple public requirement (or private initiative) could extend the economic values of a waterfront site beyond the first tier of buildings to inland sites as well.
3. Allocation should be made for recreation and commercial uses (such as commercial fishing) that require a waterfront location and are not inconsistent with the surrounding area. Adequate space within the public area will encourage the location os these uses.
4. The urban waterfront should not be planned as most other areas are, in a checkerboard pattern, with industrial uses here, commercial uses there. Regular zoning should not simply be taken to the waterline. Instead, planning for the waterfront should be radial, progressing from the specific to the general. It should be specific as to uses along the shoreline and more general as one progresses inland. It should begin with a recognition of the waterfront's particular setting. What does a person need to be able to enjoy the waterfront?
5. The aim should be to design a beginning, rather than an end product. The design should allow the dynamism brought by people who will use the waterfront in varied ways. An over-designed plan might be easier to sell, but easily crumbles with changing uses and fashions, while a design that provides structure but allows for change is likely to be long-lived.

These principles are not only consistent with an altruistic notion of the public good, they are also grounded in sound economics. When the attractiveness of a resource is enhanced, its value to surrounding business also increases.

It should also be kept in mind that the essential interest of the developer is to capture the complete value of the amenity. A developer cannot rationally be asked to do otherwise. When required only to conform to a general plan, a developer is led by self- interest to plans that call for maximum revenue-producing space. He will discount open space and access ways along the waterfront as costly luxuries in terms of foregone revenues. Developers' designs usually seek to force the public through their shops to view the water. The result is often a double- loaded (shops on both sides) passageway. Yet without access to open space and viewing areas, the local population will not be drawn to the waterfront, and projects are sure to be financial burdens rather than civic assets.

Urban waterfronts have received a major share of recent attention because of their historic and economic importance, their great resource value, and their importance as growing population centers. Local governments and private investors are rediscovering waterfronts as potentially valuable resources. A significant aspect of this rediscovery is that waterfront design—and designs for the waterfront—are beginning to reflect the natural advantages of the waterfront location.

The revitalization of a waterfront is linked to the city's economic health. A city can afford waterfront redevelopment even in an age of austerity. Amenities—that is, tangible public benefits in the form of facilities, settings, and activities— benefit not only city residents, but also the city's economic health. Amenities are now being used by public agencies as economic development tools, along with financial packaging, tax incentives, site acquisition and development, and other conventional approaches. Clearly, the public sector has a crucial role to play in achieving compatible waterfront designs and, indeed, all coastal design. Government must play the dual roles of entrepreneur and mediator, roles not typical of government, but which it is nonetheless capable of learning. Government's role also includes preparing the ground— literally, as well as politically and financially—for the development to come. Of necessity, government is taking the overall management role in waterfront design and development.

Compatible waterfront design that includes public amenities, far from being a costly luxury, is now being considered by both the public and private sector as an essential—and leading—part of waterfront development.

Conclusion

There is room for diverse interests on the waterfront and the entire coastal edge. The need for multiple uses can be accommodated in many ways. The public sector—state and local government—has a basic responsibility to foster the best and most appropriate use of the waterfront and the coast. Design professionals and their clients, as creators of structures which will dot the coastal landscape for years to come, are obligated to work within public established constraints. And of course, the ultimate responsibility for preservation of the coastal edge belongs to the public. A policy and regulatory framework can establish the boundaries within which multiple uses of waterfront land can be accommodated. Operating within these boundaries, public agencies can use the creative development approach to resolve coastal land use and design conflicts. In this way, public enjoyment and use of the coast can be achieved, sensitive coastal resources can be protected, and legitimate private investment can be made in a manner consistent with environmentally sound policies and regulations.

Biographical Note

Joseph E. Petrillo played a key role in drafting the California Coastal Plan and in shaping the bills that made it law in 1976. He was counsel for the California State Coastal Commission between 1973 and 1975, consultant to the State Senate Land Use Committee from 1975 to 1977, then became the First Executive Officer of the California State Coastal Conservancy. After nine years in that post, he resigned to go into private practice as an attorney and consultant on land use planning.

ADDITIONAL READINGS

Adams, Louise McCorkle. 1981. *The Affordable Coast*. State Coastal Conservancy.

Adams, Louise McCorkle, and Rick Adams. 1985. *The California Highway 1 Books*. New York.

Barnett, Jonathan. 1986. *The Elusive City*. Harper & Row. New York.

Bernier, Jacqueline. 1984. Commercial Fishing Facilities in California. California State Coastal Conservancy.

Burns, Jim, et. al. 1979. *A Plan for Seal Beach*. State Coastal Conservancy.

California Coastal Plan. 1975. California Coastal Zone Conservation Commission.

Caputo, Daryl F. 1981. *Open Space Pays: The Socioeconomics for Open Space Preservation*. New Jersey Conservation Foundation.

Clark, John, et. al. 1979. *Small Reports*. The Conservation Foundation.

Grice, Patricia Ann. 1980. *Future Demand for Commercial Fishing Berths in California*. California Coastal Commission. San Francisco.

Horn, Steve. 1982. *An Urban Waterfront Program for California*. State Coastal Conservancy.

Minurbi, Luciano, et. al. *Land Readjustment: The Japanese System*. Lincoln Institute of Land Policy. Boston. 1986.

Petrillo, Joseph. 1987. *Small City Waterfront Restoration*. Coastal Management, Lot 15, pp. 197-212. Taylor and Francis. New York.

Petrillo, Joseph. 1987. *How to Save a Resource: Negotiated Development*. Coastal Zone '87 Proceedings, pp. 2783-2793. American Society of Civil Engineers. New York.

Petrillo, Joseph, and Peter Grenell. 1985. *The Urban Edge, Where the City Meets the Sea*. California State Coastal Conservancy and William Kaufmann, Inc., Los Altos, California.

Petrillo, Joseph. 1984. The California State Coastal Conservancy and Conflict Resolution: Reconciling Competing Interests for Land Use in the Bolsa Chica Wetlands. *Proceedings of the Coastal Society Ninth Annual Conference*.

Petrillo, Joseph E., and Abigail D. Shaw. "The Conservancy Concept." *Proceedings of Coastal Zone '85*.

Pilkey, Orrin, et al. 1983. *Coastal Design*. Van Nostrand Reinhold Co., New York.

Rosenbaum, Nelson M. 1976. *Citizen Involvement in Land Use Governance*. The Urban Institute, Washington, D. C.

Sabatier, Paul A. and Daniel A. Mazmanian. 1983. *Can Regulation Work? The Implementation of the 1972 California Coastal Initiative*. Plenum Press.

Shoemaker, Joe. 1981. *Returning the Platte to the People*. The Greenway Foundation, Tumbleweed Press, Westminister Co.

Squire, Peverill, and Stanley Scott. *The Politics of California Coastal Legislation, the Crucial Year, 1976*. Institute of Governmental Studies, University of California, Berkeley.

State Coastal Conservancy. 1985. *Waterfront Revitalization: Pismo Beach, California*.

Urban Waterfront Lands. 1980. National Academy of Sciences.

Urban Waterfront Revitalization: The Role of Recreation and Heritage, U.S. Department of the Interior.

Abstract

DESIGN GUIDELINES FOR URBAN WATERFRONT REDEVELOPMENT

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Waterfronts are important aesthetic, economic, and recreational resources. In the past several years, many communities have implemented plans to redevelop their waterfronts. A waterfront redevelopment plan should preserve not only the economic vitality and diversity of the waterfront but its aesthetic diversity as well. In order to accomplish the latter, a waterfront redevelopment plan must entail a design guidelines package.

The purpose of this paper is to review major design guidelines for urban waterfront redevelopment. These guidelines are divided into two groups: site planning and urban design. The first group entails three specific design guidelines. These are guidelines for preserving public views of waterfront, enhancing public access to waterfront, and ensuring a compatible land use pattern for waterfront. The second group includes specific guidelines for new construction on urban waterfront, such as architecture (i.e. style, scale, bulk, height), landscaping (i.e. site furniture, plant materials), signage, and parking design. The paper ends with a number of recommendations for preparation and administration of waterfront design guidelines.

The Coastal Facilities Improvement Program, An Example of State and Local Cooperation in Public Waterfront Development

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I. Introduction:

In 1983, with the passage of Chapter 589, "An Act Relative to the Protection of the Massachusetts Coastline", the Coastal Facilities Improvement Program (CFIP) was established within the Executive Office of Environmental Affairs (EOEA). The program was initiated with an $18 million authorization and the Office of Coastal Zone Management (MCZM) was chosen by EOEA to administer the Act.

II. Legislative History:

The original CFIP legislation appeared in January 1981 as House Bill No. 2787, "An Act to Assist Coastal Cities and Towns to Finance the Reconstruction, Rehabilitation, Expansion or New Construction of Commercial Fishing Piers and Supporting Facilities". The so-called "Fish Pier Bill" was introduced by then Representative Philip W. Johnston of Marshfield. However, the "Fish Pier Bill" was very narrow in scope, and it was limited only to piers that were to be used primarily for commercial fishing operations; that were in poor, deteriorating physical condition; that were inadequate to service the expanding commercial fishing industry; that were of regional significance; within an approved Commercial Area Revitalization District (CARD); and located in a Special Assistance Development Area (SADA). The state's share of the project cost was proposed to be 80% and the local share, 20%. The local share would have been allowed to be derived from federal or other state funding sources. The limits of the state share were $500,000 for rehabilitation work, $1,000,000 for reconstruction work and $3,000,000 for new construction work. A bond issue of $30 million was requested to finance the program. This bill did not pass in the 1981 session of the legislature.

The "Fish Pier Bill" was refiled in 1983, under the same title, by Representatives Mary Jeanette Murray and Roger R. Goyette, as House Bill No. 1877. The formula for the funding of shares between the community and the state was changed to 50% each. The local share could be derived from federal or other state funding sources. The reimbursement from the state was set at a maximum of $1.5 million. There was a $30 million five year funding level recommended for the program.

Also, in 1983, Representative Johnston filed House Bill No. 5389, "An Act to Assist the Improvement of Harbor and Waterfront Facilities." This bill included a purpose section which expanded the scope of the activities to be allowed. It read, "The purposes of the Act are:

(a) to allow for expansion of economically important maritime dependent activities, including commercial fishing and shellfishing, recreational, tourist and marine industries;

(b) to facilitate harbor and waterfront improvements needed by fishermen, shellfishermen, and the general boating public;

(c) to encourage revitalization and rehabilitation of water dependent commercial and recreational facilities in harbors and waterfront areas of coastal cities and towns;

(d) to maximize the economic return and public benefit for publicly supported harbor and waterfront development."

This bill also expanded the facilities definition to include publicly owned and maintained structures and buildings within SADA's, CARD's and now Designated Port Areas (DPA). To be eligible, the facility must have been used primarily for commercial fishing, shellfishing and/or recreation related purposes. The act further described the types of projects that would be eligible for funding under this act, these included harbor channels, dredge spoil disposal areas, bulkheads, seawalls, ripraps, municipal fish piers, wharfs, docks, floats, public parking, access areas, walk-paths, and recreation parks. This bill limited the Commonwealth's 50% share to $750,000 per project and allowed the Secretary to utilize up to seventy per cent of the funds for commercial fishing and shellfishing facilities. This bill expanded the ability of the community to seek its 50% share from any source, including but not limited to, federal and state grant-in-aid and loan programs, municipal appropriations, bond financing or through bequests, gifts or other contributions made by individuals, corporations or associations. The funding authorization in this bill was $30 million.

On May 5, 1983, the Committee on Natural Resources and Agriculture recommended "favorable" action on newly numbered House Bill No. 6152. This bill was a modified combination of House Bill No.1877 and House Bill No. 5389. The bill was titled, "An Act to Assist Coastal Communities to Finance the Improvement of Harbor and Waterfront Facilities." This bill contained the "purposes" section of the legislation that eventually passed as well as the final definitions for harbor and waterfront facilities. The funding formula required that the state's share be 50% of the project costs and that there be a limit of $1.5 million for an individual project and a limit of $3 million for more than one harbor and waterfront project in an individual community. In this bill, as in House Bill No. 5389, the local share could come from any source. To qualify for the program, the project must be declared in substandard condition by EOEA, or in a CARD, SADA or DPA and the project must be principally used for fishing, shellfishing, marine commerce or industry, or for marine recreation or public access purposes. The Secretary is authorized, under this act, to utilize seventy percent of the funding for commercial use purposes. The bond authorization was for an aggregate of thirty million dollars over a five year period.

House Bill No. 6152 was then combined with House Bill No. 608, which statutorily created the Office of Coastal Zone Management within the Executive Office of Environmental Affairs, and became House Bill No. 6763. The Committee on Ways and Means gave the bill a favorable report on November 1, 1983 and retitled the bill to be, "An Act Relative to the Protection of the Massachusetts Coastline." This bill contained not only the CFIP and the establishment of the Coastal Zone Management Office but also provisions to transfer certain functions of the Department of Waterways from the Department of Environmental Quality Engineering to the Department of Environmental Management, sections amending the powers and duties of the Division of Water Resources and amendments to Chapter 91, Waterways. Some of the CFIP provisions in this bill were modified slightly and the funding recommendation was reduced by the Ways and Means Committee to $15 million, over a five year period.

The Committee on Bills in Third Reading amended House Bill No. 6763 by substituting House Bill No. 6820 for it on November 16, 1983. Again, at this point there were some minor word changes and the funding recommendation was $15 million with no time frame specified.

On December 1, 1983, the Committee on Ways and Means of the Senate recommended favorable action on an amended version of House Bill No. 6820. The Senate document, numbered Senate Bill No. 2283, had a funding level of $15 million attached to it.

A conference committee worked out the final version of the legislation. On December 17, 1983, Chapter 589, "An Act Relative to the Protection of the Massachusetts Coastline" was signed by Governor Michael Dukakis (see Appendix A). The final funding authorization for CFIP was $18 million.

III. Program Establishment:

Mr. Richard Delaney, Director of the Massachusetts Coastal Zone Management Program, established a CFIP Task Force within the Office and charged it with the task of developing the program. The Task Force was composed of Ms. Marianne Connelly, the chairman, Ms. Renee Robin, Legal Counsel, Mr. Jack Clarke, Mr. Louis Elisa, Mr. Lawrence McCavitt and myself. The Task Force, with extensive review by other state agencies, coastal communities, regional planning agencies, and the MCZM's Coastal Resources Advisory Board (CRAB), developed regulations for the program, a program guide and application, a program brochure, technical bulletins on what a substandard determination is and how it is determined, and the technicalities of the Administrative Procedures Act relating to public construction projects. Contributions of time and writing by the rest of the MCZM staff and the invaluable skills of our clerical staff enabled the Task Force to get the first application package to the seventy-eight coastal communities on August 1, 1984, eight months after passage of the law. Completed applications for Round I funding were to be submitted to MCZM at the end of November, 1984.

From August to December, while the coastal communities were preparing applications, the CFIP Task Force went on a promotional campaign for the program and began to debate the elements of the application evaluation procedure. The Task Force recommended that a primary review be conducted by a board, composed of members of a variety of state agencies, especially those agencies whose funds would be used as match or which had permitting authority over the projects. This board was and is called, the Inter-Agency Review Board (IARB) and it recommends award contingencies and funding strategies to the Secretary on each round of applications. A second review and recommendation is conducted by the Secretary's Coastal Resources Advisory Board, called CRAB. A third review and funding recommendation is made internally, by MCZM.

IV. Program Operation:

On December 1, 1984 MCZM received 21 applications from 20 communities requesting just over $8.8 million. Project applications were reviewed for completeness and eligibility by the CFIP Task Force, those deemed ineligible were returned and the rest were summarized for the IARB, CRAB and other interested parties. Award contingencies were laid out by the IARB and on February 11, 1985 nineteen contingent awards were made to 18 communities. Rounds II and III followed similar patterns. The general categories of projects awarded in the first three rounds were as follows:

PROJECT TYPE	CFIP AWARD	# OF PROJECTS
PIERS	$7,060,040.00	10 PROJECTS
BULKHEADS	$1,745,166.00	7 PROJECTS
MARINAS	$2,120,185.00	4 PROJECTS
BOAT RAMPS	$243,853.00	9 PROJECTS
WATERFRONT PARKS	$2,339,514.00	8 PROJECTS
MULTIPLE TYPES	$3,403,095.00	11 PROJECTS
TOTAL	**$16,911,853.00**	**49 PROJECTS**

V. Re-Authorization and Program Amendments:

During the Round III evaluation, MCZM knew that the bond authorization had to be increased in order to continue the program. A survey conducted by our coastal engineer, John Moore, showed that coastal communities could identify $30 million of planned public projects that would qualify under the program. Also, several communities because of increased construction costs wanted the caps per community and per project raised. During this time, MCZM was also promoting the concept of comprehensive harbor management and seeking ways to fund such plans. MCZM drafted an amended version of Chapter 21 F which re-authorized the program with $30 million, increased the maximum award amounts per project and per community, and made allowances for the funding of harbor plans. The funding re-authorization of $10 million came in Chapter 564 of the Acts of 1987, commonly known as the "Open Space Bill." The amendments to allow for harbor planning and changing the maximum award amounts was passed as Chapter 768 of the Acts of 1987.

In Round IV, with the amended funding levels, MCZM received seven requests for additional funding and ten requests for new projects. Only two of the projects are seeking funding which would of exceeded the previous limitations. Contingencies for these projects have been set by the IARB and the Secretary is about to make the awards.

VI. CFIP and the Future of Public Waterfront Development in Massachusetts:

CFIP is an exceptional program which has benefitted the Massachusetts coastal communities. Public projects involving harbor and waterfront facilities will always exist, need maintenance, restoration and rehabilitation. Communities, with the aid of programs such as CFIP, can keep their waterfront and harbor facilities in prime condition, safe, convenient and accommodating at a minimum expense to the taxpayers of the community. With the expansion of CFIP to include harbor planning, the planning efforts can give communities a real sense of direction on the future of their harbor. Once the direction is known, the most effective use of the construction funds can be made. The Commonwealth, thru CFIP, has found that public harbor and waterfront facilities are not only community assets but regional, state and national assets, as well. Their appearance, safety, accessibility and accommodation reflect on the local community and the Commonwealth. The Commonwealth commits to projects funded under this program with pride.

Appendix A

AN ACT RELATIVE TO THE PROTECTION OF THE MASSACHUSETTS COASTLINE

CHAPTER 21F.

Section 1. The purposes of this chapter are:

(a) to ensure that adequate and well-maintained public facilities exist to support the Commonwealth's fishing, marine, tourist, and recreational industry in the coastal zone;

(b) to provide flexible and affordable financial programs for the Commonwealth's coastal cities and towns so that they can plan for, construct, reconstruct, maintain and improve public coastal facilities; (c) to improve planning for coastal facilities consistent with the policies of the Executive Office of Environmental Affairs;

(d) to encourage greater cost sharing between the public and users of public facilities financed with public funds.

Section 2. As used in this chapter, the following words shall, unless the context clearly requires otherwise, have the following meanings:-

"Harbor facility", any existing or proposed public dredged channel, spoil disposal area, bulkheads, ripraps, piers, wharves, fill, docks, floats, beaches or other structures used for fishing, marine industry, or commerce, marine recreation or public access purposes.

"Harbor plan, a document which analyses existing harbor and waterfront land uses and delineates future uses. Future land uses may be described through zoning ordinances, capital improvement plans, and building design guidelines and other methods. Planning for the management of the competing uses of harbor waters may include mooring plans, facilities maintenance plans, shellfish management plans or dredging needs assessments.

"Waterfront facility", public upland platforms, public buildings containing harbor related facilities or public spaces or structures used for fish or vessel and related equipment handling or storage, and parking facilities and walkways necessary for access to said waterfront facility.

"Public", any structure or land owned and maintained by a coastal city or town or by the Commonwealth.

"Improvements", a project or undertaking involving the planning, engineering, repair, construction or reconstruction of harbor or waterfront facilities.

"Card Program", the state Commercial Area Revitalization District program established under chapter forty D.

"Substandard condition", physical deterioration, faulty arrangement or design, overcrowding, lack of access, or other factors which cause the condition of a harbor or waterfront facility to be detrimental to the public safety, health, morals, welfare or sound growth of a coastal city or town.

"Designated Port Area", any port area suitable for maritime industrial uses and so designated in accordance with the procedures established by the Department of Environmental Quality Engineering under chapter ninety-one.

"Special Assistance Development Area ", an area identified by the Executive Office of Environmental Affairs under chapter twenty-one A, having special development needs and significant resource areas which have development potential such as in ports, harbors and recreational areas.

Section 3. The Executive office of Environmental Affairs shall define the terms "coastal city or town" and shall designate such cities and towns as so qualifying for the purposes of determining eligibility for project assistance.

Section 4. Any coastal city or town, acting by and through its mayor in the case of a city, the town manager in a town having town council form of government and the board of selectmen in any other town, may apply to the Secretary of Environmental Affairs for assistance to undertake a harbor or waterfront improvement or a harbor plan. An application for assistance pursuant to this chapter shall represent no more than fifty per cent of the estimated total cost of the improvement and in no case shall exceed two million dollars for improvements in designated port areas and one million five hundred thousand dollars in all other areas. The Commonwealth shall reimburse no more than three million dollars to communities with designated port areas and at least one project within these areas or two million dollars total to a city or town applying for funding for more than one harbor or waterfront project. The Secretary of Environmental Affairs is authorized to utilize seventy per cent of the funding provided for this chapter, for public facilities used primarily for commercial purposes.

Said Secretary of Environmental Affairs is hereby authorized to utilize ten percent of the funding in this chapter for grants to prepare harbor plans. An application for assistance in the preparation of a harbor plan shall represent no more than fifty per cent of the total cost of said plan. The Secretary of Environmental Affairs is hereby authorized to approve applications for improvements and plans for up to thirty-three percent of the funding provided for this chapter in any one year.

Said applicant must provide a cash or inkind match with a value equal to at least fifty per cent of the total cost of the improvement which may originate from any source including grants, bequests, gifts, or contribution by the federal, state or municipal government or by an individual, corporation or association.

Section 5. To qualify for assistance under this chapter, a city or town shall comply with the following conditions:

(a) the improvement will be public for the duration of any debt obligation incurred by the Commonwealth relative to such assistance pursuant to regulations to be adopted pursuant to this chapter and shall be used principally for fishing, shellfishing, marine commerce or industry, or for marine recreation or public access purposes;

(b) the project site has been determined by the Executive Office of Environmental Affairs, to be in substandard conditions or is located within an approved Commercial Area Revitalization District or within a Designated Port Area or an area designated as a Special Assistance Development Area by the Massachusetts Coastal Zone Management Program within the Executive Office of Environmental Affairs;

(c) that the city or town may seek to obtain reasonable fees from users of the improvement or related facilities, that this income will be committed to the operation, maintenance, management and, if required, the retirement of any debt incurred under the provisions of this chapter.

Section 6. In making applications for assistance under this chapter, the city or town shall follow the rules and procedures developed by the Secretary of Environmental Affairs to implement this chapter which shall include, but not be limited to the following findings:

(a) the proposed improvement will serve the public interest and is consistent with community wide needs and priorities;

(b) the project will have a significant economic impact on the fishing, marine, commercial or industrial, recreation or tourist industry or provide significant public benefits;

(c) there is a clear need for the improvement;

(d) the improvement is consistent with the guidelines set by the Executive Office of Environmental Affairs and that all required local, state and federal permits, approvals and licenses, have been sought or obtained in the case of an improvement requiring such;

(e) the funds required to complete the total improvement are or will be secured;

(f) the application for assistance has been approved by the mayor in the case of a city, the town manager in a town having a town counsel form a government and the board of selectmen in any other town;

(g) funds shall not be used for dredging projects.

LESSONS FROM TEN YEARS OF PORT MANAGEMENT STUDIES

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Introduction

Since 1980 Sea Grant personnel have conducted twenty-two comprehensive port management studies in Washington, Oregon and California.

While the studied ports varied considerably in size and character, the major findings of the studies were surprisingly consistent. These findings are summarized in this paper.

Pacific Coast Ports

Pacific coast ports are administered by elected or appointed commissioners who in turn employ a staff to carry out the various port activities. (Schmisseur, 1979) The twenty-two ports studied since 1980 ranged in size from a medium size port handling 9 million tons of cargo and generating $10 million in revenues from cargo handling, industrial parks and commercial property to a tiny port with one staff person, a small fishing dock and $15,000 in annual revenue. These are typical of the smaller Pacific Coast Ports.

Comprehensive Management Studies

Comprehensive management studies are conducted by a team of three to five university and port specialists. In recent years an active port manager from a previously studied port has joined the study teams. Activities include a three to five day site visit, an oral report to port administrators at the end of the site visit, a more comprehensive written report to port administrators several weeks later and a follow up evaluation within twelve months.

The study team inspects port related documents and facilities, observes the port in action, and interviews port staff, port clients and community leaders. Comprehensive management studies are instigated by Sea Grant extension staff who request the ports' cooperation, organize and carry out the study.

The studies include examination of port administration, management, finance, planning, marketing, community relations, economic development and port operations. (Smith, 1988)

Lessons

Lessons from these studies can be classified as follows:

inventory assets and strengths,
improve finances,
upgrade accounting,
accept administrative responsibilities,
streamline management,

carry out planning,
understand economic development and
communicate with the taxpayers.

Inventory assets and strengths

There was an opportunity for ports to better understand their comparative advantage. Most ports had at least one natural asset that gave them a comparative advantage.

It was not because they had just constructed a new marina, or purchased a new crane, or just obtained a $200,000 grant. Ports needed to recognize that they had a comparative advantage because they were:

located on an important transportation and communication corridor,
relatively close to an urban and commercial center,
surrounded by harvestable forests,
in a rich agricultural region,
close to productive fishing grounds,
near famous scenic attractions.

Strengths that may offset a lack of natural assets included the vision, skill and energy of commissioners or directors, quality of the staff, the state of infrastructure and superstructure, and community support.

Improve finances

Every port studied had opportunities to improve their financial situation as well as financial management. Ports seldom matched their debt servicing requirements with their cash flow and often carried a complex and confusing mixture of debt. Refinancing and restructuring debt was a convenient method for matching debt service with cash inflow and reducing interest and other debt service costs.

Few ports recognized or took advantage of refinancing. Long term general obligation bonds were used to finance operations while short term high interest loans were used to cover infrastructure improvements with 20 to 30 year lives.

Long overdue accounts receivable were another common problem. Ports had an opportunity to implement relatively simple collection procedures but were apparently concerned about the community relations impact of such actions.

In twenty-one of the twenty-two ports studied, there was an opportunity to improve the quality of financial information produced. There was frequently a lack of feasibility analysis on capital projects and very little financial planning for development and implementation for these projects. Also, the opportunity costs of committing the ports scarce financial resources to the current popular project was seldom considered in depth.

Upgrade accounting

Ports had no difficulty meeting their statutory accounting requirements, but this seldom met administrative and management needs. There was a general need to upgrade all accounting and financial information, including:

- a comprehensive balance sheet,
- a monthly income and expense statement providing comparative data from the previous year and from the income and expense budget projections made at the beginning of the year,
- a monthly cash flow projection for at least 12 months and a cash flow statement from the previous 12 months for comparison,
- enterprise accounts for the various cost centers at the port and finally,
- budgets for all new capital projects including activity schedules.

Since 1980 when the comprehensive port management studies began, ports' access to personal computers has increased ninety percent. Unfortunately very few of these computers were being used to produce timely management information. Now that personal computers are more common, there is an opportunity to improve their utilization and to get them on the managers desks.

Accept administrative responsibilities

Many of the studied ports did not have sufficient staff for normal operations the port and commissioners were frequently involved in day-to-day activities. However, commissioners were rummaging in details and working on the docks even where there was sufficient staff. When commissioners used their scarce time for operational matters they could not perform their policy making and administrative responsibilities.

In many cases staff pulled commissioners into operational details and in some cases commissioners involved themselves because they felt uncomfortable dealing with larger policy issues. Inordinate amounts of commissioner time were often devoted to the proper color of paint, the best place to purchase replacement tires and whether the maintenance crew should wear uniforms. Pressing and important policy decisions were deferred and often not made.

Delegation of responsibility and authority downward was also a common need and one that staff frequently desired even though commissioners were reluctant to delegate.

Inefficient and sloppy meetings were another common problem. While commissioners frequently defended meeting informality because it encouraged public participation, the legality of many informally made decisions was questionable. Security, performance and professional appearance of port commissions could be greatly improved with more control over meetings, more formal agendas and more formal decision making procedures.

Streamline management

Opportunities for streamlining management included improvements in personnel management, management information, time management and delegation of responsibilities.

Job descriptions were a rare commodity in the studied ports. Without job descriptions performance evaluation was difficult at best and the work of each staff was subject to the daily whims and feelings of the manager, and sometimes the commissioners. The negative impact on morale and performance was clear.

In addition to preparing job descriptions for staff there was an opportunity to establish more formal and routine evaluation procedures. Each employee needed to know the criteria by which he or she would have been evaluated and should have been familiar with the process.

Not only were there opportunities to improve management information as identified above, but there were opportunities to improve management and staff ability to use this information. Also, widely accepted time management procedures were badly needed among the twenty-two ports studied.

Finally, many opportunities to delegate responsibility and authority downward were found among the studied ports. Talented and intelligent people were being under-utilized because "the boss was doing everything".

Carry out planning

While most ports had developed property use plans there was a lack of strategic or business plans. Commissioners were commonly skeptical and suspicious of planning, but the lack of planning explained most ports financial and other problems.

Widespread community leader involvement in the community planning process was also not very popular among the ports studied. Some commissioners thought the port was theirs and the community should not interfere in plans and policies.

Understand economic development

Nearly half the ports studied felt that economic development meant bringing in new industry to the community. Too many ports were missing opportunities to help create new port enterprises and to help existing enterprises survive and grow. Also, better understanding of the ports assets and strengths was an important factor in bringing about beneficial economic development.

Communicate with the taxpayers

The majority of ports studied were communicating well with their taxpayers. However, they were also having major problems resulting from inadequate targeted communication efforts.

A majority of studied ports relied on the port manager to carry the community relations burden, yet the commissioners were the elected and appointed representatives of the community. It was their responsibility to report to the community. Also, elected or appointed commissioners were usually much better placed to interact with community leaders.

There were opportunities to improve the esthetic appearance of the ports, to involve community leaders in port committees, to hold port meetings at times and locations more convenient to interested taxpayers and to present themselves in a more professional manner at these meetings.

Summary

Twenty-two comprehensive management studies have been conducted in Oregon, Washington and California since 1980. Ports studied ranged in size from a cargo handling port with $10 million in revenues to a small fishing port with $20,000 in revenues.

The lessons to be learned from these studies applied equally to all ports, whether large or small.

Lesson 1. A comprehensive inventory of port assets and strengths led to greatly improved policy formulation, more accurate planning and steadier economic development,
Lesson 2. Matching debt sources with uses and utilizing cash flow budgets saved interest costs and financial embarrassment,
Lesson 3. Reducing overdue accounts receivable was a simple and easy process,
Lesson 4. More financial and management information greatly improved decision accuracy and efficiency,
Lesson 5. Improved accounting was possible with current staff and computing capacity,
Lesson 6. Administration was improved when commissioners paid more attention to policy matters (their responsibility) and left port operations to the staff,
Lesson 7. Commission performance improved when they looked and acted more professional at commission meetings,
Lesson 8. Staff morale and productivity improved when they knew what was expected in the work place and were given authority to do it,
Lesson 9. Economic growth was more steady and community confidence increased when strategic planning was implemented and,
Lesson 10. Economic development "happened" when energy was invested in "homegrown" enterprises.

Bibliography

Smith, Frederick J., The Port of Beaver: A Case Study of Port Management, Oregon State University Extension Service, EM 8278, 1988.

Schmisseur, Edwin, Oregon Port Commissioners: The Job and How to Seek it, Oregon State University Extension Service, EC 971, 1979.

Weber, Bruce, F. J. Smith and M. L. Liffmann, Smaller U.S. Ports: What They do and How They are Financed and Governed, Oregon State University Extension Service, (in process).

Port Everglades—An Urban Port Challenging the Need for Intergovernmental Coordination

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Introduction

Florida is one of the fastest growing states in the nation. Since 1980 almost 2 million people have moved into the state, and in 1987 Florida overtook Pennsylvania as the 4th most populous state in the nation, with an estimated 12 million residents. This growth has been a mixed blessing—providing a strong a prosperous economy, but generating a huge backlog of unmet infrastructure needs, inadequate public services and environmental degradation. Nowhere is this growth and its impacts more apparent than along the state's coastline, where approximately 80 percent of Floridians are expected to live by 1990. In response to these growth-generated problems, policymakers put sixteen years of effort into developing a progressive growth management system to plan and regulate the timing, location, type, and intensity of development. In the coastal management section of the law, § 163.3178, *Florida Statutes*, deepwater ports specified in § 403.021(9), *Florida Statutes*, must submit a comprehensive master plan to the "appropriate local government and shall be integrated with and shall meet all criteria specified in the coastal management element."

The 1985 growth management laws brought Florida's twelve deepwater ports under comprehensive planning requirements for the first time. Although most of the ports have a document which they refer to as a "master plan," such plans hold little resemblance to the document outlined in the *Florida Statutes* and the requirements specified by the Florida Department of Community Affairs (the state land planning agency) in their rules for implementing the law (e.g., Minimum Criteria Rule, Chapter 9J-5, *Florida Administrative Code*.) Port Everglades, located in and around the cities of Fort Lauderdale, Hollywood, and Dania in Broward County, Florida, contracted with the Florida Atlantic University/Florida International University Joint Center for Environmental and Urban Problems, a growth management and urban studies research center, to help facilitate the production of its comprehensive master plan. The Joint Center's role was not to produce the written plan, but rather to develop a framework wherein the Port could meet both state and Port Authority objectives.

The main goal was to develop a plan that meets state guidelines and continues to be of use in the day-to-day operation of the Port. Of almost equal importance was developing a plan that addressed and resolved conflicting uses of the Port. The latter was no minor task because while the benefits to intergovernmental coordination are considerable and generally considered worth working toward, there are inherent barriers to intergovernmental coordination. The obvious barriers, such as complicated governmental structures and overlapping responsibilities, are apparent, but the more subtle problems that stem from poor communication, creating false expectations and endless frustration, are less visible and are often overlooked. So the first task at hand was to create an environment conducive to open exchange of ideas and information. To accomplish this, the Joint Center created the Port Everglades Master Plan Task Force, including representatives of all interested parties. The Task Force was able to develop the entire plan in less than five months. This success was due to a process designed to resolve intergovernmental conflicts, especially with regard to infrastructure placement and land use designation. Resolving the predictable conflicts proved to be challenging, but not unsurmountable.

This paper highlights the significance of the Port Everglades Master Plan Task Force, describes the Port, presents an overview of the evolution of Florida's planning and land use regulation system and the current requirements for deepwater ports' plans, and discusses those factors leading to a successful resolution of conflicts among the participating local governments.

Significance

Spurred by rising public concern for environmental protection, a number of states, including Florida, passed legislation mandating planning and regulating land use. One of the underlying concerns was the need to find an effective means to manage multijurisdictional issues such as floodplain management, siting of locally unwanted land uses, pollution control, transportation projects, and large-scale developments. With state, and sometimes regional oversight, states such as North Carolina, Florida, Colorado, Nevada, California, Oregon, and Hawaii created land use planning and regulatory programs to manage environmental and growth management problems. With this state oversight, many states structured programs to manage problems at a scale appropriate to the problem.

The mid-1980s brought a new wave of growth management legislation. This time the focus has shifted somewhat from environmental issues to regulatory efforts to address problems associated with aging and inadequate infrastructure. New Jersey, Maine, Massachusetts, Georgia, and South Carolina have passed growth management laws to help them cope with the pressures of growth. Meanwhile, Florida and Oregon revisited their growth management programs to fine tune them, and California has experienced a barrage of local initiatives to contend with infrastructure backlogs. At the crux of this issue is the public's concern for maintaining a quality-of-life standard. While solid waste, water, sewer, parks, schools, recreational facilities, and open space are components of the infrastructure spectrum, the focus is clearly on transportation. And nowhere is that more evident than in an high growth state like Florida.

The authors believe that the techniques used to resolve conflicts in the Port Everglades Master Plan development process will be of interest to governmental entities, port authorities, and industries associated with viable port operation because they are transferable to other regions and states. Techniques to resolve conflicts through intergovernmental coordination are necessary, and often mandated, where land uses are regulated at a state and regional level. However, there is an inherent value in intergovernmental efforts that adhere to recognized techniques to resolve conflicts and promote consensus. The introductory material describing Florida's port planning requirements will be of interested to those lawyers, planners, and government officials concerned with monitoring the operation of the growth management regulatory system in Florida.

Port Everglades

Port Everglades Authority is a 2,100 acre jurisdiction located within Broward County on Florida's southeast coast. It is Florida's deepest harbor, with access only fifty yards from the shipping lanes. Geographically, a quiltwork of municipal boundaries overlay the Port jurisdiction. The cities of Fort Lauderdale, Hollywood and Dania, as well as unincorporated parts of Broward County, are within the Port boundaries.

Over the years Port Everglades has grown through massive diversification. Its cargo tonnage has increased from 342,000 tons in 1935 to over 15 million tons in 1987. Its growing cruise ship business has increased from 160,000 passengers in 1970 to over 1 million in 1987. Port Everglades has installed state-of- the-art gentry cranes and other off loading equipment modified to handle the giant Atlantic class vessels.

Consistently, the Port breaks its previous records in the amount of cruise and cargo business. To date it is the second largest cruise port in the world, with more five star rated vessels than anywhere else. Port Everglades also boasts the country's second largest petroleum tank farm, handling thirteen million tons of petroleum a year. Other major products include lumber and cement.

The Port boasts a myriad of other uses within its jurisdictional boundaries. Most notable are the plans for a new $46 million Broward County Convention Center to be located at Northport in the northern regions of Port Everglades. This is a county financed project, but it will be augmented by a $200 million festival marketplace built with private dollars. Facilities will include two world class hotels, an office tower, portside shopping malls and considerable parking facilities. Groundbreaking should be near the end of 1988.

The Port is a major tourist destination for ships other than cruise ships, hosting between 150 and 200 military vessels from all over the world each year. The community sponsors many events for these special visitors. Also located on the Port Everglades grounds is a major steam generated electricity plant operated by Florida Power & Light. This plant provides electricity for one million residents of Broward County.

With so many diverse uses on a commercialized industrial site, it is a challenge to protect the fragile environment and endangered species in the same geographical area. Port Everglades included several models of efforts which are national examples in this respect. Manatees, sometimes called sea cows, are an endangered species of mammals, and several hundred spend most of the winter in this area. Port Everglades established a manatee sanctuary for nursing cows and newborns. In general, a conservation program exists to help protect not only manatees but other species within the Port jurisdiction. Many areas of the Port are also lined with mangroves, presenting even a tougher challenge in developing this area.

Governmentally, Port Everglades Authority was established in 1959 by the Florida Legislature as an independent governing body. It is composed of a seven-member governing board, five members elected county-wide and two members appointed by the County Commission, (one to represent labor interests and the other to represent the business community). Port Everglades Authority has the ability to levy ad valorem taxes countywide, but currently they do not, rather operating the Port on an entrepreneural basis.

Florida's Growth Management Laws

After thirty years of rapid population growth, the drought of 1971 lead to a critical water shortage in south Florida. This crisis precipitated four major pieces of legislation: first, the State Comprehensive Planning Act, requiring the development of a state comprehensive plan to guide actions at all other levels of government (Chapter 23, *Florida Statutes*); second, the Water Resources Act, creating the water management districts (Chapter 373, *Florida Statutes*);third, the Environmental Land and Water Management Act, regulating certain types of development that, because of their nature, have a regional impact and all development in certain areas having significant regional or statewide importance (Chapter 380, *Florida Statutes*); and fourth, the Land Conservation Act, initiating the state's land acquisition program of environmentally endangered lands (Chapter 250, *Florida Statutes*).

Although great strides were made during the implementation of these programs, by 1980 it was apparent that there were major weaknesses in Florida's growth management system. Continued population growth, at the current rate of approximately 300,000 people each year, combined with federal retrenchment in infrastructure finance lead to a mounting dilemma—how could local governments even keep up with roads, schools, libraries, etc. required by new growth while maintaining their level of service to current residents or slow the rate of growth and economic expansion? Other weaknesses were emerging as well. For example, because the state plan lacked the force of law, there was a policy vacuum; regional and local governments were not required to further the goals of the state plan in their plans. Local governments could amend their plans at will, leading to zoning-driven planning whereby local plans were amended with each rezoning decision. Conflicts between local governments usually resulted in litigation, and policies to limit development in high-hazard coastal areas were undermined by state road and bridge construction policies. These issues were visited with a new wave of legislation in the 1980s.

In 1984 the Florida Legislature passed the State and Regional Planning Act, which created the framework for a legally binding set of policies that, once combined with the policy mandates of the 1985 Growth Management Act, require state agency functional plans, regional policy plans, and local government plans to address and "further" the policies in the State Comprehensive Plan. Thus, each plan promotes the goals and policies of plans higher in the hierarchy. Setting the pace for the state agency functional plans are three fast-tracked plans: the State Land Development Plan, the State Water Use Plan, and the State Transportation Plan. These plans were completed first because proper management of land and water is so vitally important in Florida, and transportation systems, more so than any other aspect of infrastructure, guide development. Previous problems with intra- and interplan consistency were addressed with a comprehensive intergovernmental consistency review process. And citizen standing was expanded in the early stages of the plan review process to ensure that residents as well as neighboring local governments could express their concerns and objections to neighboring governments' plans. In an effort to discourage zoning-driven planning, the Legislature required that all land development regulations and orders be consistent with local comprehensive plans and restricted local plan amendments to only twice a year. In addressing the infrastructure backlog, the Act required that public services and facilities be available "concurrent" with the impacts of new development. And finally, the Growth Management Act restricted the use of state funds to construct or rebuild bridges or causeways to coastal barrier islands.

There are several keys to the success of Florida's planning system. First is the regulation of developments, which due to their size, location, and nature, have a regional impact. Second is state regulation of unique environmentally sensitive areas of critical state concern. Third is the consistency doctrine, mentioned earlier, which brings coherent sense to Florida's planning policy framework. Fourth is the concurrency doctrine, which ensure adequate infrastructure is available to serve existing and new residents. Fifth is equalized treatment of developers. Previous to the 1985 Growth Management Act, developers of large projects were required to undergo stringent regional and state review to ensure they were minimizing the negative impacts of that development; now local governments are required to strengthen their local plans so the negative impacts of all development is minimized. Sixth is the expanded standing provisions to challenge local plans. And seventh is state funding for local and regional policy plan preparation, which has been in excess of $10 million since 1986.

The Port Everglades Master Plan is now required to be developed along strict guidelines, according to the new state growth management laws. This plan must fit within all affected locale's coastal elements, i.e. Fort Lauderdale, Dania, Hollywood and Broward County. The Port Authority was given $100,000 through a State Department of Natural Resources grant program to assist with the development of the Master Plan.

Port's Historical Conflict with Neighbors

Port Everglades' very independence as a governing body has created its own set of conflicts. Historically, it has been viewed as somewhat of a poor neighbor by surrounding governments. Some of this image has been brought about by the Port's propensity to operate without communicating its plans very clearly to its neighbors.

To a certain extent, even Port land within municipal boundaries has been outside municipal control, and this structure has led to a variety of conflicts involving land use, zoning, development standards, development decisions, and even the issuance of building permits. The zoning question is one of the few areas wherein municipalities have had clear control, creating a four color patchwork which at times has been a nightmare to business interests within the Port. Several years ago the Legislature intervened in this solution, urging a unified and simplified system within the Port jurisdiction. This compromise was successfully established, with municipal control remaining.

Sometimes unrealistic ideas about how the Port should be developed have been forthcoming from municipal sources. For example, one city expressed concern that the convention center should be located in the south part of the Port, because they did not want a containerized cargo moving facility near their city, preferring to be near a convention center. In general, these Port versus municipality confrontations have been brought about because there was no outlet to discuss the conflicts between governments. In response, differences were always confrontational and usually combative.

From the other side, Port Everglades viewed itself as unlike other local government service providers, being very business- like in its nature and providing no social services or related types of services to a resident population composed of businesses. The Port saw the cities as having no business dabbling in port matters. The new planning laws, which not only encourage but mandate cooperation between these levels of government provided an opportunity to build communication bridges and to develop projects like a master plan without the characteristic strife. The present Port Everglades Commissioners are very receptive to changing the combative image and are making a very strong commitment to strategic planning.

Techniques Used to Reduce Conflict

The University approached the Port Authority to offer assistance in developing their master plan to meet the state guidelines. A very basic technique, involving the formation of a task force of all affected parties to meet on a regular basis during plan formation, was established. Membership of the Port Everglades Master Plan Task Force included representation from the county government, all three city governments, the regional planning council, the water management district, another local planning authority, the Port Authority itself, Port consultants, and a neutral facilitator. The University filled the role of a neutral facilitator.

Meetings were held monthly, or on a more frequent basis, during the six month fast-tracked plan formation. These meetings were held at a neutral site, usually at the University to lessen tension. Mayors, city managers, and executive directors of the cities involved were notified of the process, but actual membership on the task force was composed of planning staff from each of the entities.

Local governments were given an important opportunity to review, comment, and critique the Master Plan on a chapter-by-chapter basis. This input was especially helpful in developing the infrastructure data needed by all locales. Comments sometimes changed the way the Port's long term plans were presented. One good example was modification of very "soft" long term plans regarding controversial roadways. Once a roadway line is drawn on a map, it has a way of taking on life of its own, even without funding in place to build such a road. The Master Plan process made the Port staff sensitive to some city concerns, and also provided some of the data the cities needed for their plans. Both sides left the Task Force with a clearer picture and greater sensitivity to the data needed by all to formulate their plans. A series of public hearings on the Master Plan were then held, directing specific invitations to attend toward special interest groups, businesses, environmental groups, and local municipal officials.

Results

The outcome of this process has been generally better communication between the Port Authority and its neighbors. The process has enabled to the Port begin building a trust foundation between it and the various governments. However, this does not mean that there will be no further conflicts during the planning process, but is an indicator that communication lines have been opened. At this stage, the Master Plan has been accepted with little or no comment into the Broward County Comprehensive Plan, and indications are that the cities will follow suit.

Several guiding principles in using a similar task force for conflict resolution during planning are listed below. The principles are intended as a guide in setting up a task force tailored to individual need:

1. Include all affected parties.
2. Learn to share information. Societally, we are taught not to share but to hoard information, as information is power. Shared information is imperative to the success of a project such as this.
3. Carefully choose a neutral facilitator, not a share-holder in the process.
4. Select a neutral meeting place.
5. Hold frequent meetings.

The moral of this story is that it is hard to criticize what you have had input into. The Port did not change its plans through the master planning process, it only shared them with its neighbors.

Seaport and University Cooperation: A Plan for Rhode Island

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The relationship between the academic community and the numerous port authorities within the United States needs strengthening. Although several ports and universities, primarily on the West Coast, have been working together for nearly ten years to solve port management and operations issues, the overall interaction between educational institutions and port authorities throughout the country is minimal. Through the efforts of the Rhode Island Port Authority, the Rhode Island Sea Grant Marine Advisory Service, and the University of Rhode Island, a new relationship that will provide mutual benefits to the state port authority and the state university by developing closer ties between them has begun. The program will serve a dual purpose by providing port officials with data gathered by students on a variety of port related issues, and by offering students academic credit for their hands-on work in real-life situation.

The goal of this program is to match the needs of the port authority with the academic expertise of the university. Achieving this goal will result in more effective, efficient, economical and environmentally safe development of the Quonset Point/Davisville Park, as desired by state officials and the people of Rhode Island. The program will also allow university students to become more familiar with actual problems and the decision-making processes involved in handling legitimate issues within their respective field of interest.

Ten years ago cooperative efforts between ports and universities were a novelty. Today, although the connection between port authorities and the world of higher education is improving, the relationships remain very informal. They are easily bogged down by red-tape, and can be difficult to get started, maintain and grow.

Traditionally the port industry has avoided direct contact with formal educational institutions. Professional port personnel have been skeptical of the applicability of academic projects and research to the real world of port management, and this skepticism has been returned in kind by university scholars and faculty who viewed port managers as lacking the ability to understand the value and use of their work. On the other hand, seaport organizations have always been indirectly associated with colleges, universities and trade schools. Access to operational statistics, public relations tours, interviews of port staff, and public speaking engagements by port personnel are a few examples of this traditional unstructured relationship.

During the past twenty-five years education and research have increased in importance at port authorities around the world. Competition between ports has become intense, changes are continuing to take place in general and financial management philosophies, and the need for highly trained personnel, and state-of-the-art equipment and facilities are essential for a port to secure its share of the word's commercial cargoes. These factors alone are sufficient to justify active pursuit by port authorities of the benefits of education and research developments made by colleges and universities. In the same vein, academic institutions can serve as catalysts by defining applied research projects that will assist port personnel in the management of their ports and provide practical experiences for faculty and students.

Several world ports and terminal operators have informal working arrangements with various universities for a variety of projects. The placement of interns within the port organizational structure, easy access to port facilities for field instruction purposes, and the use of port organizational, marketing and other information for studies are the most common. It is easy to envision how the benefits from these relationships accrue to both parties. The industry managers receive analyses of different aspects of their operation that may help to facilitate their decision-making process and the academicians achieve a clearer understanding of how the industry operates, thereby allowing them to better direct future research efforts.

The ports of Rhode Island are like most ports of similar size. They have small staffs, equally small operating and capital budgets, concentrate on the immediate needs of the day, and require the services of professional consultants for many valuable projects. However, unlike most ports with similar staff sizes and budgets, the port of Rhode Island possess physical and geographic resources most ports envy. In particular, the Rhode Island Port Authority facilities at the Quonset Point/Davisville Industrial Complex, offer an incredible variety of existing uses and the potential for many more.

The Port of Providence and the Quonset Point/Davisville Industrial Park are the major commercial ports facilities in Rhode Island. In order to have a better perspective on the types of maritime resources available in Rhode Island and, especially a feel for the potential at QPD, a few details of both locations are necessary.

The Port of Providence, located at the head of Narragansett Bay, is a traditional industrial port that serves the southern New England region. The port, accessed via a navigational channel with a depth of 40 feet, has 3300 feet of lineal berthing space, 85 acres of back-storage area, two container cranes and all the associated services of a commercial port operation. Petroleum products, automobiles, lumber, steel and scrap iron are the ports major commodities.

Located ten miles upstream form Brenton Reef light tower, the Rhode Island port Authority's Quonset Point/Davisville Industrial Park is best viewed from the air. The piers at Davisville are the main commercial docking facilities at QPD. With working aprons of eight and fifteen acres respectively, piers one and two are actively used for the handling of automobiles. In 1987, the Narragansett Bay Ports formed the tenth largest auto importing center in the United States. In spite of declines in auto imports from Japan during 1988, the ports expect to show growth due to the addition of several new European accounts.

Major emphasis on engineering projects can be seen throughout the park. Pier one is under review for strenghthening and modernization with the intention of bringing it up to the state- of-the-art standards of the new $1.6 million fender system installed along pier two. Roadwork, sewage systems, electrical services and several other areas are also being addressed.

There are several additional major components of the QPD complex that should be noted. Quonset Point is home to one of the country's largest shipbuilding firms, Electric Boat Company. With 5,000 employees, the submarine hull section manufacturing plant at QPD is one of Rhode Island's largest employers.

The property uses within the QPD complex go beyond that of the maritime sector. The most visibly striking feature of the QPD area when viewed from the air is the airport. Now operated as a general aviation facility by the Rhode Island

Department of Transportation, the airport has an 8,000 foot runway and is capable of handling most of the world's largest aircraft. Many acres have been set aside for light commercial and industrial development, many old buildings have found new, non-marine related uses, and work towards a balance of uses is on-going.

A major concern to local residents and recognized by the state as well, is the applicability of a percentage of the complex's property for recreational uses. Allen's Harbor is a well protected small harbor area that is jointly shared by the Navy, the local town of North Kingstown, and the RIPA. It is a popular center for recreational boating and fishing, with an adjacent undeveloped sand beach. However, the most popular site at QPD is the golf course. A well-maintained public course, it is conveniently located and serves as a good example of the possibilities of multiple uses of the property.

Critical to preserving the balance of man's interference into the natural environment, the port authority and the Rhode Island Department of Environmental Management have worked together to establish "fragile zones" that are to remain undeveloped. These include upland acres of trees and lakes, as well as beaches and marshes. The purpose of this intra-agency cooperation is to preserve critical natural habitat to ensure the diversity of wildlife will continue within the complex.

As you can imagine, the variety of present and future uses of this former US Naval Base has placed requirements on the state for considerable research in a broad range of disciplines. With 2000 acres of land, deep water docking facilities, one of the longest aircraft runways on the east coast, easy access to inland highway systems, full railroad service, undeveloped tracts of woods and marshes, and a golf course, it makes an ideal working laboratory for practical applied research and study projects by university graduate and undergraduate students. In addition it is easy to list other related areas of concern that affect the port's ability to function as efficiently and effectively as possible. These include such topics as EDP applications, market research, labor relations, finance, inter-governmental relations, legal issues, politics, facilities engineering, planning and many more. The facility is arguably one of the most desirous multi-use real estate sites in the United States.

This wide range of uses and possibilities is complemented by the courses and research being conducted at the university. The University of Rhode Island offers excellent programs, many with national and international reputations, in areas that pertain directly to the management, planning, design and use of this strategic property. Programs from chemical and ocean engineering, to aquaculture and fisheries, to landscape architecture, natural resource management, labor relations, public administration, resource economics, business administration and marine affairs are a few of the areas that would find compatibility with the states ports.

Due to the scope of the work and range of enterprises that are conducted at the QPD Industrial Park, federal, state, local and private sector personnel can be involved in any given project. To ensure effective initial involvement and interaction by university personnel and port authority staff, coordination of these activities is necessary. The Rhode Island Sea Grant Marine Advisory Service is acting in this capacity. The Marine Advisory Service has met with port personnel to identify areas of immediate concern to the authority and to discuss the potential of university involvement in those areas. Meetings have been arranged between port staff and faculty members to work out the details of this new relationship between two of Rhode Island's major organizations.

There are three primary steps to be followed to reach the point at which port managers and university administrators can join in a formal relationship that will provide new educational experiences for students, faculty and port professionals and simultaneously serve the best business and industrial development needs of the state. These steps are 1) focus on initial entrees into each others area of expertise; 2) consistently return to the resources and services of the other organization; and 3) review, analyze, and provide recommendations for creating formal ties based on experiences is steps on and two.

Working on step one Rhode Island is developing a plan that will follow the lead of those successful, but loosely arranged port and university partnerships that exist today. Intern programs and formats for the involvement of port authority staff in the educational process as guest speakers at university seminars are being drafted. These are first steps are normally the limits of most port and university interactions throughout the country. Rhode Island, however, is in a position to go beyond these limits by having the state's higher education institutions and ports of Narragansett Bay formalize their working agreement.

Like most business and governmental administrations and their staffs, those of port authorities and universities are similar in at least one major area. They tend to return time and again to work with those agencies and individuals with whom they have had previous success. This repeat business is the type of long-term relationship that the ports and universities of Rhode Island can establish. This is the second step in the process of achieving a formal tie between the ports and the university. The goal of this step is to have the port authority and the university call each other first when deciding where to go for answers about research needs, staff assistance, student instruction and/or employment and applied industry projects.

After a two or three year period of projects, the final step towards a formal, structured agreement, should occur. An advisory committee of port and university personnel should be established. Their purpose would be to conduct a review of any on-going and completed enterprises undertaken during the informal relationship period, study other examples of such relationships around the country and develop recommendations for review by the port authority board and senior university administrator.

Reaching this final level will require patience and perseverance by both organizations. The ground rules for such an endeavor must include the willingness to "get to know" each other, understand each others objectives, goals and missions, to learn each others strengths, and find the best methods to capitalize on those strengths for mutual benefit. A unified approach of this type can be used to help answer business and industry questions, provide new avenues for education and applies research, and offer different perspectives on the management of Rhode Island's educational, commercial and natural resources.

COMPETING IN THE INTERNATIONAL LINER TRADE: THE CHALLENGE FOR PUBLIC PORT AUTHORITIES

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Introduction

Public port authorities face two types of challenges in today's liner trade.First, as any business enterprise, they must be competitive in offering services to their customers.Second, as a public entity, they must justify that their actions are in the public interest.

This paper describes the competitive structure of the international liner market.The types of investments to be made and services to be offered by a public port authority are described.The types of reactions to be expected by the public are also discussed.The paper comments on the degree of difficulty that different types of public port authorities can expect in meeting current challenges.

The Business Environment

The international liner market consists of common carriers moving oceanborne trade consisting mostly of manufactured and semi- manufactured goods.Ocean carriers use published sailing schedules and published tariffs.Almost all modern liner vessels are capable of carrying marine containers and most major liner operators in U.S. foreign trade operate fully cellular ships.

A key factor of international liner trade is the degree of concentration that exists.For example, Exhibit 1 shows that of 336 ports that responded to a survey by the *Containerization Yearbook 1988*, the top 20 ports handled 51.4% of all the containers in 1986, measured in twenty-foot equivalent units (TEU's).

The trend in concentration among containerports goes hand-in-hand with the concentration among liner operators as shown by an analysis made by *Containerization International* in their October 1988 issue.Of the more than 600 companies offering container liner services, the top 20 carriers accounted for 60.3% of the TEU capacity of existing fully cellular containerships and 72.7% of those on order, as shown in Exhibit 2.In addition, by the middle of 1990, these carriers will control almost 89% of all the fully cellular containerships of 2500 TEU capacity or larger.

In this environment that contains some giant carriers and ports, it is useful to think in terms of categories of sizes.The customer base of liner companies being sought after by ports can be divided into three tiers or layers, consisting of large, medium, and small.The first tier, or industry giants, possesses quite different customer needs than the third tier, or smallest size carriers.Each port must decide if it will focus on one or two particular tier of carriers or will try to meet the needs of all categories of liner firms.The needs of each tier are described below.

EXHIBIT 1
World Container Port Traffic 1986

No. Port	1986 TEU	Country/Region
1 Rotterdam	2,939,200	Netherlands
2 Hong Kong	2,774,025	Hong Kong
3 Kaohsiung	2,482,468	Taiwan
4 New York/New Jersey	2,340,000	USA
5 Singapore	2,203,100	Singapore
6 Kobe	1,882,921	Japan
7 Keelung	1,587,328	Taiwan
8 Busan	1,448,225	South Korea
9 Long Beach	1,394,453	USA
10 Los Angeles	1,324,547	USA
11 Antwerp	1,313,155	Belgium
12 Yokohama	1,310,498	Japan
13 Hamburg	1,245,964	West Germany
14 Tokyo	1,082,049	Japan
15 Bremen/Bremerhaven	1,000,274	West Germany
16 Oakland	925,089	USA
17 San Juan	899,052	Puerto Rico
18 Felixstowe	895,244	UK
19 Seattle	850,504	USA
20 Tacoma	666,152	USA
TOTAL	30,564,248	
WORLD TOTAL RECORDED	59,449,332	
TOP 20 SHARE (%)	51.4	

Source: *Containerization Yearbook, 1988.*

EXHIBIT 2

Top 20 container service operators based on projected TEU slots in service by mid-1990, analyzed on the basis of fully cellular (& converted to cellular) ships, TEU capacity and number of ships (in parentheses).

OPERATOR	CURRENT TEU'S (NO. SHIPS)	TEU'S ON ORDER (NO. SHIPS)
Evergreen	112,594 (64)	6,858 (2)
Maersk	75,359 (41)	31,200 (8)
Sea-Land	101,330 (51)	
NYK	59,992 (36)	
MOL	49,877 (23)	
APL	53,659 (23)	8,680 (2)
K-Line	45,735 (27)	10,350 (3)
Yangming	46,817 (20)	10,500 (3)
Cosco Shanghai	32,206 (31)	13,620 (5)
ZIM	39,172 (34)	10,800 (4)
OOCL	47,553 (26)	7,000 (2)
Hapag-Lloyd	39,388 (19)	6,700 (3)
Hanjin/KSC	38,788 (21)	10,660 (4)
P & OCL	37,606 (20)	7,210 (2)
CGM	15,531 (11)	2,525 (1)
NOL	24,329 (15)	9,900 (3)
ScanDutch	33,232 (18)	
BSC	12,350 (16)	
Nedlloyd	12,613 (08)	
POL	1,513 (01)	3,026 (2)
TOTAL	889,576 (505)	139,029 (44)
WORLD TOTAL	1,474,897 (1,280)	191,251 (83)
TOP 20 SHARE (%)	60.3 (39.5)	72.7 (53.0)

Source: "Top 20 Lines on Course for Larger Slice of World Fleet", *Containerization International*, October 1988.

First tier carrier

The first tier carriers are industry leaders that typically provide an integrated total transportation service from origin to destination. The ships and ports are just elements in the total system. A true first tier carrier should be able to differentiate itself from the industry in general on the basis of price and /or quality.

A first tier carrier will generally own huge containerships and lease modern port facilities. This carrier may own double-stack container rail cars, a stevedoring firm, a trucking company and a worldwide information system.

Third tier carrier

It is easiest to describe the third tier carrier next because of the dramatic contrast with the first tier firm. The third tier firm can be thought of as a market niche player. Within this small segment of the market, this liner operator has a competitive advantage. The niche may be caused by any of a large number of factors, such as: flag of registry in a politically/ legally restricted trade, a certain type of cargo, a particular shipper, a unique type of vessel either in terms of physical parameters or cargo handling characteristics, a unique type of port facility served, a remote geographical location receiving service from only this carrier, or a particular relationship with the port labor force.

The third tier carriers typically have limited resources. All non-vessel services are generally provided by other parties, such as stevedores, intermodal firms, and information services firms.

Second tier carrier

The second tier is made up of all the remaining carriers. In terms of numbers of carriers, this tier is probably the largest on any given trade route. Although these liner operators are larger and possess more resources and services than the third tier carriers, they lack the market focus and competitive advantage of the third tier firms. On the other hand, the second tier carriers are lacking in both resources and services when compared with the first tier companies. Consequently, the second tier firms are more vulnerable than either of the other two tiers and will basically depend on the basic supply-demand relationship in the market for their profitability (or survival).

Needs of each tier

Each tier of carrier may require quite different port facilities and services. The first tier carrier is looking for huge modern intermodal port facilities. In addition, it requires good road and rail access to the port. Typically the first tier carrier will be desiring facilities for handling double-stack container trains, hopefully on or very near the docks.

In contrast, the third tier firm has limited but specialized needs. The second tier carrier may pose the most ambiguous situation. This carrier would like to utilize the same type of facilities and services used by the first tier company. However, the second tier firm does not possess the financial resources to afford these luxuries. There are many services that the port can provide or coordinate for the second tier firm, such as warehousing/ distribution, truck and rail services, and information services. A port can even use services to substitute for facilities. For example, rather than providing on-dock facilities for double-stack trains, the port can absorb the drayage of moving the container to an existing rail yard for such an activity. The port could also build an inland port to help substitute for more expensive and extensive facilities on prime waterfront property.

Public Reaction

Segments of the public will be watching the public port authority because of concern for a number of different factors. These concerns typically fall in one of the three following categories: economics, land use, or environmental. Each category is described below.

In addition to being concerned with the overall cost/benefit relationship of investments made by the public port authority, the public is also interested in the distribution of those costs and benefits. For example, consider a large investment in on- dock facilities at a West Coast port to handle double-stack trains for movement to Chicago. To the extent this investment has a negative return on investment, the costs involved may be largely borne—directly or indirectly—by the local taxpayers. On the other hand, this same facility may bring significant benefits to shippers and consignees of cargo a few thousand miles away.

The public may feel that a new port facility is not the best use for a particular piece of prime waterfront property. They may feel that a port terminal is not compatible with adjacent property (e.g. residential). They may think that other commercial uses may bring greater economic benefits. Finally, they may feel that the land should be utilized as a public recreational area.

Port activities such as dredging and landfill will have environmental impacts on the water-side. On the land-side, port activities may cause traffic congestion, air and noise pollution, and possible public safety problems.

Predicted Outcomes

Ports focusing on third tier carriers should not encounter problems with the public. Typically, such a port is underutilized. The specialized facility neded by the carrier generally results in local benefits that are easy to recognize and support.

The port that attracts a first tier carrier will have to provide extensive facilities; however, this investment will result in significant benefits. Because of the financial resources of the first tier carrier, the port will be taking little financial risk. On the other hand, the public may not like the distribution of costs and benefits. In fact, as the port becomes more successful, the local taxpayers may become more concerned with resulting by-products such as traffic congestion and pollution.

The port focusing on second tier carriers may face the widest range of public reactions. The port is faced with the widest range of choices and the carriers may have limited financial strength. Consequently, the port may find itself having to justify why it did not take alternative actions and why it appears to be taking high financial risks.

Lessons To Be Learned

The above discussion shows that strategic planning must be an essential activity at every public port authority serving the international liner trade. A port must define its role and mission as well as its financial objectives and guidelines. The port must consciously decide on which carrier tiers it will focus on.

The port must keep a dialogue going with its users, the government agencies from whom it will need future permits and approval, and the general public. The port must be aware of alternative uses for property it is desiring for future development. A constant effort must be made to communicate with the general public to effect understanding and cooperation.

The port dealing with a third tier carrier should encounter little public opposition as long as it keeps the public informed of what it is doing. The port focusing on the first tier carrier must emphasize long range planning. Its investments and activities will have potentially large impacts on both the waterfront and inland areas. It is essential that the public feels that it has input into this planning process.

The port focusing on the second tier carrier must consciously determine the amount of financial risk it is willing to take. The port must be willing to analyze the wide range of alternatives open to it and be prepared to explain and discuss its rationale with the general public. Without doubt, all ports must do their planning for the future carefully.

BIBLIOGRAPHY

American Association of Port Authorities, "Strategic Planning: A Guide for the Port Industry", Alexandria, VA, 1988.

Containerization Yearbook 1988, National Magazine Co., Ltd., London, England, 1988.

Dowd, Thomas J., "Considering Strategic Planning for Your Port?", Washington Sea Grant, Seattle, WA, 1987.

Gibney, R.F., "Container Lines: The Strategy Game", A Lloyd's Shipping Economist Study, Essex, England, November 1984.

Japan Maritime Research Institute, "Advent of the Large Scale Intermodalism and Underlying Problems", JAMRI Report No. 27, Tokyo, Japan, April 1988.

__________ "The Effects of Containerization - The Winners and The Losers", JAMRI Report No. 14, Tokyo, Japan, February 1986.

__________ "Where Conference and Non-Conference Carriers Meet: What Fixed-Day-of-the-Week-Service Aims At", JAMRI Report No. 23, Tokyo, Japan, November 1987.

Marcus, Henry S., *Planning Ship Replacement in the Containerization Era*, Lexington Books, D.C. Heath and Company, Lexington, MA, 1974.

__________ "Trends in U.S. Liner Shipping: Past, Present and Future", World Conference on Transportation Research, Vancouver, May 1986.

Marcus, Henry S. and Martland, Carl D., "Moving Marine Containers By Rail", May 1985.

Pearson, Roy and Fossey, John, *World Deep-Sea Container Shipping*, Gower Publishing Co. Ltd., Harts, England, 1983.

Porter, Michael E., *Competitive Advantage*, The Free Press, New York, NY, 1985.

__________*"Competitive Strategy"*, The Free Press, New York, NY, 1980.

Sclar, Michael L. and Reeve, John G., "Global Outlook for Container Trade", The 5th Container Technology Conference, London, December 1984.

Sclar, Michael L., "The Future of World Trade and its Meaning for Ports", Seatrade International Ports Congress, Ghent, October 1988.

"Top 20 Lines on Course for Larger Slice of World Fleet", *Containerization International*, The National Magazine Company Ltd., London, England, October 1988.

"Cruises to Nowhere": Legal and Policy Implications of Casino Cruiseships

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Introduction

During the past two years, five cruiseships offering "cruises to nowhere" have commenced operations from the Gulf Coast ports of St. Petersburg, Panama City and Pensacola, Florida; Biloxi, Mississippi; and Port Fourchon, Louisiana. Since 1984, similar cruises have enjoyed varying degrees of success from a number of ports in south Florida and California. The term "cruise to nowhere" refers to a cruiseship that sails from a U.S. port into international waters (usually three miles from shore) for a period of hours and then returns to the same port. Generally, cruise lines provide passengers with daily or twice-daily cruises that include meals, live entertainment, dancing, sight- seeing, alcoholic beverages and gambling in fully-equipped casinos.

Most of these cruiseships have been welcomed by port officials and local citizens as a source of much needed jobs and tourist- related revenue. Cruiseship operators have projected impressive economic benefits for coastal communities. Owners of the Panamanian registered *Europa Star*, a 167 foot vessel operating from the port of Biloxi, Mississippi, initially estimated that just under 100,000 people would sail on the vessel the first year and that 25,000 to 50,000 of those would likely stay overnight in Biloxi Hotels (*The Clarion-Ledger*, 1987.) All food and supplies would be purchased from local suppliers. In addition, the cruise line predicted that it would hire sixty Biloxi-area residents on a permanent basis and that forty more employees would be required during busy periods. It is not surprising that many coastal communities in search of ways to improve their ailing tourist industries or to reinvigorate deteriorating waterfronts have looked to cruise lines offering "cruises to nowhere" as an important method of achieving these goals.

Until relatively recently, shipboard gambling took place only on large cruiseships that sailed to the Caribbean or other far off places for periods of days or weeks at a time. As a consequence, local citizens and government officials usually paid little attention to the potential legal and political problems associated with gambling aboard these vessels. The "cruise to nowhere" concept, in contrast, allows passengers with a very small investment of time and money to gamble only a few miles from shore. This has caused some to argue that unlike traditional cruises, "cruises to nowhere" are principally designed for evading state gambling laws. Most states have some form of constitutional or statutory prohibition against gambling as well as significant numbers of citizens that are adamantly opposed to the legalization of most forms of gambling. Moreover, there are several federal laws that may have an impact on how and where casino cruiseships operate.

The purpose of this paper is to inform port managers and policymakers of the laws and policies currently governing casino cruiseships in the United States. Following a brief overview of relevant state and federal law, it will provide a case study of the cruiseship *Europa Star* operating out of Biloxi, Mississippi. Currently, the owners of the *Europa Star* are involved in litigation with the state to determine whether gambling is prohibited within Mississippi Sound. An examination of this dispute will illustrate the kinds of legal and political issues that may face other cruiseship ports. Finally, the paper will suggest some steps that port and municipal officials can take to improve their chances of a successful port/cruiseship partnership.

Laws Governing Offshore Gambling

State laws

The Submerged Lands Act of 1953, 43 U.S.C. 1301 et seq., grants each state title to and ownership of the lands beneath navigable waters to a seaward boundary three geographical miles distant from its coastline. States have long exercised their police power to enforce criminal laws within internal waters and the adjacent three mile territorial sea so long as it does not expressly conflict with federal law and supreme power of the United States to regulate commerce, navigation and issues relating to national security. *Toomer v. Witsell*, 334 U.S. 385 (1947).

All states with the possible exception of land-locked Nevada and a portion of New Jersey have constitutional or statutory prohibitions against most kinds of gambling within state territorial limits. These prohibitions vary from state to state, but all clearly forbid commercial vessels from engaging in gambling activities within the three mile territorial sea. Some states have more restrictive laws than others. For example, California has enacted strict anti-gambling legislation that not only prohibits gambling within state waters but also the solicitation or enticement of any person within the state to a gambling vessel within or outside of the jurisdiction of the state. CAL. PENAL CODE §§1300 et seq. (West 1988). Florida, on the other hand, has passed legislation favorable to the cruiseship industry that specifically exempts foreign-flag cruiseships that are in port or transiting the territorial sea from being in violation of a state statute that prohibits the possession of gambling devices. 44 FLA. STAT ANN. §849.231 (West 1988).

It is unclear to what extent state laws governing gambling may be preempted by federal law. In 1984, the California Attorney General issued a legal opinion that concluded that a proposed "cruise to nowhere" off of the coast of San Diego would violate California's gambling ship statutes. He asserted that although gambling would only take place beyond state waters, the state has sufficient legitimate interest in curtailing commercial gambling by its citizens to assert the application of its statutes even to gaming activities beyond territorial seas and regulated by federal law. (Van de Kamp, 1984). The validity of this position has not been affirmed by a court of law, however, it should be noted that as a result of the Attorney General's opinion, the cruise line that proposed the "cruises to nowhere" off San Diego abandoned its plans in favor of cruises to Ensenada, Mexico. (Gordnier, 1986).

Federal Gambling Ship Statute

In 1948, Congress enacted the Federal Gambling Ship Statute, 18 U.S.C. §§1081-1084. The purpose of the statute is to assist states that might otherwise not be able to curtail certain gambling activities occurring off the coast. The Act prohibits any American vessel, American citizen or American resident from operating or owning any interest in a gambling ship on the high seas or not within the jurisdiction of any state. It also prohibits the transporting of passengers from any U.S. port

Unique legal characteristics of Mississippi Sound

When Europa Cruiselines, Ltd. chose to operate a cruiseship within Mississippi Sound it faced a number of legal impediments unique to that body of water. The Sound is located immediately south of the mainland of the states of Mississippi and Alabama and is approximately eighty miles long and ten miles wide. It is bounded on the south by a line of barrier islands located between eight and twelve miles from the mainland.

In *United States v. Louisiana* (hereinafter *The Mississippi Boundary Case*), 470 U.S. 67 (1985), the United States Supreme Court was called upon to decide whether the mineral resources found under Mississippi Sound belonged to the adjacent states or to the federal government. The Court ruled the Sound to be a "historic bay" and as such under the jurisdiction of the states of Mississippi and Alabama rather than the federal government. As a result, the boundary of the state of Mississippi has been extended significantly seaward from the customary three mile limit to a point three miles south of a line connecting the offshore barrier islands. Vessels operating in the Sound must sail up to fifteen miles out to sea before being completely outside of state territorial waters.

Although the Mississippi Boundary Case clearly awards Mississippi and Alabama ownership of the submerged lands underlying the Sound, the full extent of state jurisdiction is not explicitly stated in the decision. It is unclear whether the Court awarded the full bundle of rights associated with sovereign ownership, including the right to enforce criminal laws, or whether it was instead concerned only with setting or defining boundaries for purposes of determining ownership of submerged lands pursuant to the Submerged Lands Act. This ambiguity is at the heart of the legal dispute between the *Europa Star* and the State of Mississippi.

Europa Star litigation

Prior to the *Europa Star*'s initial voyage, its owners expressed their intention to sail at least three miles from the shore of the mainland, but not beyond the barrier islands before allowing passengers to gamble. They argued that the state had no police power jurisdiction over those portions of the Sound that are over three miles from either the mainland or barrier islands. In response, the Sheriff of Harrison County pronounced publicly that the vessel must move outside the Sound before any gambling is permitted and that he would enforce the laws of Mississippi that prohibit gambling within the territorial limits of the state. Moreover, the State Tax Commission stated that it did not recognize the right of the *Europa Star* to sell alcoholic beverages within state territorial limits due to the presence of gambling equipment on board.

On December 18, 1987, Europa Star Cruise Line Ltd. and PCDC filed suit in the Circuit Court of Harrison County to obtain a temporary restraining order that would require the Sheriff and State Tax Commission to abstain from enforcing state gambling and alcohol control laws in that portion of the Sound defined as "more than three miles south of the mainland and more than three miles north of the barrier islands." The temporary restraining order was granted and *Europa Star* began offering cruises the next day.

On January 7, 1988, the circuit court issued a preliminary injunction that enjoined state officials from enforcing the gambling and alcohol control laws against the *Europa Star* until such time as the case could be heard on the merits. The court awarded the injunction because it found that the cruise line would have a substantial likelihood of prevailing if the merits of the case were fully presented, and that there was a substantial threat of irreparable injury in the form of economic loss and loss of good will if the preliminary injunction was not granted. The court based its decision on the fact that the cruise line had relied upon a formal opinion by the U.S. Customs Service (later rescinded, *see infra* for discussion) that declared the area in which the *Europa Star* proposed to operate outside of state territorial limits. In addition, the court agreed with *Europa Star's* contention that the Mississippi Boundary Case only addressed ownership of submerged lands beneath waters within the state's boundaries and did not grant unlimited police powers including criminal jurisdiction.

Early in 1988, a coalition of coastal legislators became concerned about the actions of the State Attorney General's office in pursuing the enforcement of the state's anti-gambling laws and of the possibility of losing the *Europa Star* to another state. In an effort to pre-empt any legal action, they sponsored House Bill No. 413 which authorized gambling aboard any vessel of at least one hundred and fifty feet in length operating from a port bordering on the Mississippi Sound unless prohibited by municipal referendum. The Bill passed the House but was defeated in Senate Committee. Coastal legislators made it clear that a similar bill would be introduced during the next legislative session.

On February 23, 1988, the Mississippi Attorney General filed a motion to dissolve the preliminary injunction and, in the alternative, requested an interlocutory appeal to the state supreme court. The state argued that *The Mississippi Boundary Case* and Miss. Code Ann. 3-3-5 clearly provide that the *Europa Star* is subject to the police jurisdiction of Harrison County, Mississippi as long as it operates within any portion of the Sound. Affidavits were attached to the motion from officials of the Mississippi Bureau of Marine Resources testifying to the fact that the agency has for many years enforced state fishery, seafood and boat safety laws throughout the Sound, including those portions in question.

Rather than granting or denying the state's motion to dissolve the preliminary injunction, the circuit court held the motion in abeyance and certified the interlocutory appeal to the Mississippi Supreme Court. On July 20, 1988, the supreme court entered an order which denied the interlocutory appeal and sent the case back to the circuit court for a ruling on the motion to dissolve as well as a ruling for or against a permanent injunction. *Europa Cruise Line Ltd., et al. v. State of Mississippi, et al.*, 528 So.2d 839 (Miss. 1988). The high court held that the lower court must make a ruling before it will hear an appeal.

In an important turn of events independent of the pending litigation, on October 7, 1988, the U.S. Customs Service rescinded its previous opinion and ruled that if the *Europa Star* fails to move three miles south of the barrier islands during its excursions, it will be in violation of the Federal Coastwise Trading Act. It seems that the agency relied on an outdated map for its previous opinion.

In response to the changed circumstances presented by the revised Customs opinion, on November 8, 1988, the circuit court dissolved the preliminary injunction that allowed the *Europa Star* to continue operating within the Sound. As a practical consequence of the ruling, *Europa Star* must lengthen its cruises from six to eight hours as well as to subject its passengers to the heavier seas commonly encountered beyond the barrier islands. Cruiseship representatives initially asserted that the changes would have little economic impact, but have since stated that they intend to move the *Europa Star* to St. Petersburg, Florida unless legislation allowing gambling and liquor sales within the Sound is passed during the 1989 legislative session. (*The Clarion-Ledger*, 1988). Meanwhile, the state continues to pursue its case against the cruiseship including a claim to have the Europa Star pay back taxes on all liquor sold and consumed in the Mississippi Sound.

Although many of the legal problems confronting the *Europa Star* are based on the unique jurisdictional characteristics of Mississippi Sound, the attendant political, economic and legal pressures that have played such an important role in shaping events to date will likely occur wherever "cruises to nowhere" are offered. By looking at what has occurred in Biloxi, as well as other ports, it is possible to develop a few suggestions aimed at assisting port managers and policymakers to more successfully deal with casino cruiseships in the future.

Steps Port Mangagers and Policymakers Can Take to Avoid Future Problems

1) *Contact appropriate government officials as soon as practicable.* Formal legal opinions from the State Attorney General and District Customs Service should be requested at an early stage. If possible, an attempt should also be made to gauge the local State and District Attorneys' professional and personal opinion of the proposed cruiseship. It is common for the same legal issue to be interpreted differently by individual government attorneys located in different cities. Make sure that all officials know precisely how and where the cruiseship will operate to avoid confusion at a later date, as occurred in Mississippi with the *Europa Star*.

2) *Keep abreast of any changes in federal policy concerning the Gambling Ship Act and "primary object" of the vessel.* Should the Justice Department change its policy and rule that gambling is the "primary object" of vessels offering "cruises to nowhere", such voyages may be prohibited and ports may suffer as a consequence. This is especially true if ports have invested in costly dock or harbor improvements to accomodate the cruiseship.

3) *Survey the attitudes of local citizens and legislators.* Strong local and regional support for the cruiseship may have some influence on state and federal policy and is essential should some form of legislative action on behalf of the cruiseship be necessary at a future date.

4) *Port should be indemnified by cruise line for legal expenses.* If possible, any port/cruiseship concession agreement should contain a provision that requires the cruise line to indemnify the port for legal expenses incurred as a result of any legal action brought by the federal or state government. The port of Biloxi has been forced to expend a sizeable amount of resources defending its interest in the State of Mississippi's suit against the Europa Star.

5) *Port should seek to participate in the regulation of gambling on board the vessel.* Although cruise lines will likely never agree to such an arrangement, a port should attempt to have some provision placed in the concession agreement requiring the vessel to comply with the gaming standards of Nevada, New Jersey or some other standard. Because casino cruiseships are registered under a foreign-flag, the only gambling regulations in effect are those of the flag nation. Even if these nations have gambling regulations, they are likely not to be enforced on cruiseships operating thousands of miles away. As a result, foreign-flag cruiseships are essentially self-regulated. Although most cruiseships treat their passengers fairly in the hope of gaining return customers, there have been reports of stingy pay-outs on some vessels. Ports have a stake in the success and reputation of the cruiseships

sailing from their facilities and therefore should have some minimal control over how shipboard gambling is conducted.

REFERENCES

Brousard, H. 1988. Telephone conversation with Hatie Brousard, Regional Counsel for U.S. Customs Service, New Orleans, September 14, 1988.

Clarion Ledger. 1987. "Gambling Ship Ready to Set Sail Off Coast". The Clarion Ledger, Jackson, Mississippi, December 13, 1987 E 11-12.

Clarion Ledger. 1988. "Gambling Ship Leaving Biloxi For Fla. Port". The Clarion Ledger, Jackson, Mississippi, November 11, 1988 1A.

Gordnier, J.A. 1986. Letter from California Attorney General's Office to Mr. Curtis A. Golden, State Attorney, First Judicial Circuit, State of Florida, dated May 6, 1986.

Pensacola News. 1986. "Golden Takes Dim View of Ship Gambling". Pensacola News Journal, Pensacola, Florida, January 18, 1986 1A.

U.S. Customs Service. 1984. U.S. Customs Service Opinion Letter VES-5-10-VES-3-02, July 19, 1984.

Van de Kamp, J.K. 1984. Legal Opinion from the California Attorney General addressed to Mr. Edwin L. Miller, District Attorney, County of San Diego, dated march 22, 1984.

HARBOR RESTORATION IS DIFFICULT-BUT WORTH IT THE BALTIMORE CITY CASE

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Introduction

Baltimore Harbor is located on a tidal tributary to the Chesapeake Bay, a 180-mile long estuary that is the largest in the nation. It has thrived as a port from its beginning in 1729 when the Maryland legislature authorized commissioners to "lay out a town on the north side of the Patapsco River" to be called Baltimore. It's proximity to nearby grain-growing areas and in the Midwest proved the biggest advantage because water transport was cheaper than land transport of goods.

As the port grew, larger and larger pieces of land were needed and larger ships needed longer docks. The smaller facilities downtown were first given over to the passenger steamers and later abandoned. This trend has spread, with the supporting industries moving along with the shipping to outer harbor sites. Smaller, unrelated industries also moved to larger sites in outer City or suburban areas. This left many small abandoned properties along the waterfront with rotting piers and crumbling bulkheads.

The City began a dramatic revitalization effort in the downtown area in 1965, and for the past 23 years has steadily followed that plan with evident results. In addition to the "revitalization" of the waterfront, the plan also supported the removal of many sources of pollution, spurring correction of leaking sewers and abandoned industrial properties. The inclusion of a public access promenade along the water's edge raised the awareness of the Harbor's condition and development of an Inner Harbor marina focused the water quality improvement effort.

The Port of Baltimore still thrives, receiving more than 4,000 ships and 37 million tons of cargo yearly. Over $300 million in state and local taxes are generated by the Port which employs about 79,000 people. The new development is thriving, too. More people visit the Inner Harbor than Disney World and waterfront land near downtown sells for over $1 million per acre. This success both helps and hurts the natural environment of the Patapsco River.

The many programs to clean-up the Chesapeake Bay have helped to raise the priority of environmental restoration plans. With 52 miles of tidal shoreline, and 12% of the City's land within 1000 feet of the shore (6,200 acres), the importance of this area cannot be ignored. The Harbor waters, while supporting an amazing variety and number of foraging fish and crabs, are virtually devoid of oxygen below the first two feet in the summer and the bottom sediments are badly polluted. Toxic materials discharged by manufacturing, refining and shipping industries as well as oxygen demanding organic sludge from centuries of untreated sewage rest on the bottom. Some sewer overflows and stormwater run-off during wet weather contribute to high bacterial counts, preventing water contact recreation.

Despite these conditions, our restoration program has produced noticeable results in the areas immediately surrounding restored wetlands and shorelines. All projects have not been successful, however, and many variables contribute to the difficult situations presented by the abuses of the past. Many restoration projects are not off-the-shelf items that contractors do routinely. City inspectors are not necessarily attuned to look for a certain problem or know how crucial a few inches can be when grading an area for wetland plantings. Patience and persistence are required at all stages.

How to Restore a Harbor

There are three essential ingredients to a successful restoration of a working harbor. First, there must be a need for or a vision of what you want to restore—and others who can see it. Second, you must see and take advantage of all opportunities that appear that will help you achieve that restoration. Third, only persistence and follow-through will bring about that vision—it will not happen if it doesn't serve the needs and desires of many parties.

These three steps must be repeated over and over if harbor restoration is to be successful. Let me describe how we are doing this in the Baltimore Harbor.

The Baltimore Harbor Environmental Enhancement Plan

The environmental laws of the early 1970's and the desires of environmental agencies at all levels of government created a need to severely restrict filling in the Harbor. The ground was laid for this effort in 1974 when the Federal permitting agencies asked the state and local government to develop criteria for allowing fill in the Harbor. The Baltimore Harbor Plan, published in 1975, provided a vision for land uses along the Harbor shoreline and conditions under which fill in the Harbor could be justified.

The next step was taken when a federal directive was issued stating that all fill projects had to be mitigated. Mitigation for each project had to be individually negotiated, consuming vast amounts of time both for the reviewing agencies as well as the applicant, delaying needed fill. In 1980, the Baltimore Harbor Environmental Enhancement Task Force was convened to develop a comprehensive plan for the Harbor's restoration that formed the basis for the needed mitigation projects.

A grant from the Maryland Coastal Zone Management Program provided the opportunity to further study the restoration of the Harbor. The Regional Planning Council (a metropolitan council of governments) applied for a grant to work with the three local jurisdictions, as well as state and federal governments to determine if such a plan would work. The first year of work showed that there were locations where physical improvement was feasible and that local plans would support such environmental enhancement activities. The plan was then prepared, with the aid of the Task Force (consisting of representatives of all of the interested agencies including the Port Administration). It strongly recommended that whenever mitigation was required, that it be undertaken within the confines of the Harbor, preferably at or near the site of the fill. A list of environmental improvements was developed and weighed against the mitigation requirement of various fill projects. Potential locations for each type of enhancement were identified. Examples of each type of activity were located and designed, and costs estimated.

The plan also recommended that mitigation banking be accepted and institutionalized through a state or independent non-profit agency. Once the permitting agencies had determined that a fill project was necessary, the applicant could pay into a dedicated fund that would be used to construct environmental enhancement projects. The fee would be set on an area for area basis, as determined by the agencies. The enhancement projects would have to be pre-approved as part of the overall enhancement plan and would have to stay ahead of the need for mitigation. The plan also recommended that all parties sign an agreement to implement its recommendations.

The follow-through, the longest phase of the plan, meant getting the approval of all agencies to go along the recommendations. The agreement was finally signed in 1983, but only after the mitigation banking concept was dropped. However, the idea of doing mitigation and enhancement in the Harbor was retained, and has been relatively successful ever since. Over 30 acres of new wetlands have been created, doubling the acreage within the city limits. Now anyone needing a mitigation site in the Harbor goes to the local jurisdiction which suggests sites (usually from the plan) that will further its local enhancement goals. Local governments link these projects with public access activities, upland enhancement and non-water-dependent industries wanting to improve their shoreline and image.

The Critical Area Management Program—A Second Chance

The Maryland Critical Area Law was designed to protect the first 1000 feet of land surrounding the Chesapeake Bay (the "Critical Area"), especially a 100-foot green buffer that would provide wildlife habitat and filter stormwater pollution. This created a second dilemma for the City of Baltimore. How could the City continue its redevelopment of old port lands and still comply with the state law? Many of the properties were abandoned by port users specifically because of their small size, many land parcels no more than 200 feet deep and selling for $1 million per acre. The City's plans also called for a continuous public promenade along the water's edge thus precluding vegetated shoreline.

This gave the City a second opportunity to apply the banking concept-this time to the upland environment. We developed a concept of buffer offsets, allowing the land to be developed down to the water's edge in the revitalization area, with the landowner paying a fee that would be dedicated to restoring the habitat along the water's edge in another area of the City. In industrial areas of the waterfront where land parcels were much larger, non-water-dependent users were allowed to disturb only 50% of the 100-foot buffer.

The fees are structured to cover the design, engineering, construction and maintenance of new habitat at or near the water's edge within the 1000 foot Critical Area. In most cases, the creation of new habitat is planned for land devastated by previous urban use including landfills, storage of bulk materials or wastes, junkyards, etc.- all common uses of former marshes and wooded lowlands at the water's edge. Based on the estimated cost of revegetating such lands (excluding the "wild card" of toxic materials removal and land acquisition), the fee was set at $2.50 per square foot of land disturbed within the 100-foot buffer. Only land area dedicated to public access, cultural and educational uses which contribute to the public understanding of environmental issues, are exempt from this fee.

Follow-through on this concept was also important. Careful study of the potential effect of such requirements was essential to convincing economic development interests that industrial uses would be allowed sufficient flexibility for growth. Guidelines had to be carefully crafted to give this flexibility while showing the state that the goals of the Critical Area Law would still be accomplished. The ordinances establishing the City's Program had to be passed by the Planning Commission and the City Council. Challenges were raised by both the private port industries and waterfront developers who asserted that the new regulations would increase costs to a level that would put them out of business. The best argument we had was that in other Maryland jurisdictions around the Bay, development (with the exception of specific water-dependent activities) was *prohibited* within the buffer area. Passing the regulations took six months. Since they became effective in January, 1988, almost 100 projects have been reviewed at some level. Only a handful have had fees assessed, and none have been collected (this will be done at the time of occupancy). The fees are expected to generate as much as $3 million in the next three to five years, depending on the pace of new development.

Ingredients for Success

Building of consensus and support is essential to the entire process. Environmental efforts, especially at the local level are often the last priority for funding and staff efforts. State and federal grants and laws, no matter how insufficient, must be knitted together to form the loose weave of a Harbor restoration program. Constant vigilance over the program is needed to keep the fabric whole and to reinforce areas of weakness with new programs and citizen support.

Supporters and critics alike must be invited into the process, buying into the goal that a better environment is good for economic development as well as for birds and bunnies. Educational and recreational interests can be some of the best advocates of such a program, spreading the word and involving volunteers in clean-up and awareness projects.

In Baltimore, we have been successful in connecting the Bay research findings regarding sources of pollution, parks and wildlife planning for greenways, state and federal requirements for buffers and mitigation, and Bay clean-up funds in a package that continues to support the restoration of the natural environment of the Port of Baltimore.

CRITICAL AREA MANAGEMENT PROGRAM

BALTIMORE CITY

---CRITICAL AREA BOUNDARY

Marina's in Urban Ports: Public Access or Public Nuisance

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Traditionally, urban ports and harbors were dedicated almost exclusively to industrial and commercial uses, and these waterfront operations played a vital role in the community's prosperity. As transportation methods evolved, goods that were previously transported almost exclusively by water began to be dispersed by other means. In addition, the maritime shipping industry has also increased its efficiency through the utilization of containerized shipping. Together, these factors lead to a diminished need and subsequent use of the waterfront for marine-industrial purposes. Therefore, extensive stretches of urban waterfronts became blighted and dilapidated. Contrary to this decline, since the mid-70's the urban waterfront has been rediscovered as both an area for housing and recreation. As people moved to the waterfront they sought out the recreational benefits that the waterfront afforded. For a variety of reasons, boating has been the primary choice for recreational activity in urban locations. Today in many urban areas, the popularity of, and demand for, recreational boating facilities far outstrips the supply of available slips and moorings. Developers have responded to this imbalance between supply and demand with a record number of proposals for expansion of existing and the building of new recreational boating facilities.

To use Boston Harbor as an example that has seen such growth the following figures are given:. In the mid-70's Boston Harbor's recreational fleet consisted of approximately 300 boats, and a couple of marinas. At the present time, Boston Harbor supports well over 3000 recreational boats with 9 marinas, 4 sailing schools, 5 sailing clubs and 14 yacht clubs. There are presently plans being submitted to state environmental permitting agencies for several new marina facilities as well as the expansion of some existing marinas. Until the supply of mooring and docking facilities meets the demand by urban recreational boaters, development proposals for marina facilities in urban harbors will continue to proliferate.

Recreational boating may be the primary boating activity in most urban ports but urban ports support other varieties of maritime activities as well. These include; fishing vessels, tugboats and barges, large commercial vessels (either break-bulk, containerized cargo, or tankers) and in some instances, commuter ferries and tour boats. Therefore, although recreational boating in urban ports can have many positive aspects such as; providing increased public access to the heritage of humanity, the ocean; be a scenic addition and add variety to an urban waterfront; provide diversity to the maritime economy; and increase public consciousness of the pollution problems most urban ports and harbors face, the uncontrolled growth of recreational boating in an urban harbor can give rise to significant negative impacts to the more traditional uses of the urban waterways. Several negative aspects that are the result of the extensive development of recreational boating facilities include: the contribution to harbor pollution from bilge pumps and the discharge of sanitary wastes into waterways; conversion (and subsequent displacement) of traditional maritime docking facilities into more profitable recreational boating facilities; and the increased congestion in the use of the waterways and shipping channels of an urban port.

In an urban port such as Boston, the vast majority of commercial traffic is ushered past marinas and other recreational boating facilities to commercial port facilities located deep within the port. Due to this configuration, recreational boats and large commercial vessels all share in the use of relatively narrow shipping channels and navigable waters within the harbor. This intermixing of large commercial vessels with recreational boats raises strong concerns for those pilot operators who must bring in the large commercial vessels. The potential liability implications, should a commercial vessel collide with a recreational boat are difficult to calculate but have the potential to be astronomical and could force a smaller commercial operation into bankruptcy. Therefore, there is enough concern among port pilots and shipping firms that if a port becomes too congested and the potential for a boating accident involving a recreational boat is significant, these maritime businesses may turn to other, less congested ports to off-load and/or on-load their cargo. This loss of shipping will result in a negative economic impact to an urban community.

There are several potential solutions that could be applied to this congestion problem that will minimize the probability of a serious boating accident. Legislation could be passed that would require all owner/operators of recreational boats to undergo an educational program and formal licensing similar to an automotive driver's license. Presently, the only thing a potential boater needs is the money to purchase a boat and a place to store it. There are absolutely no requirements for any actual knowledge of even the most basic nautical skills or customary rights-of-way for these potential boaters. However, the recreational boating lobby is very strong in most states and past attempts to pass legislation that would require a formal boating license have consistently failed.

Another solution that could be used, but again is difficult to implement, is that of greater enforcement of existing waterways regulations and if necessary new and stronger regulations. The inherent difficulty with the enforcement of such regulations is that the watersheet is not a controlled environment like a roadway and a harbormaster can not easily just stop and ticket a boater who is violating a specific harbor regulation. To overcome this obstacle would require a major financial investment by the community to support the staff and equipment requirements for a substantial harbor patrol. Due to the significant expenditure that would be required to implement such an option it will not be cost effective and will not receive the necessary local support.

One solution that can be applied to minimizing the conflict on the waterways is to develop a management plan for the watersheet itself. Presently, traditional approaches to planning take a landside view where the planner will go to the outermost point of a pier and turn their back on the water and look landward at the development constraints that a recreational boating facility may be subjected to (land-side access, parking, etc.). Little if any consideration is given as to how the marina will interface with the surrounding environs on the water itself. This lack of an all encompassing approach is a major contributing factor to the present congestion problems that some urban harbors are now beginning to face.

In formulating such a management plan, an important tool that can be applied to analyze the impact of new recreational boating facility proposals on traditional maritime interests, is a computer model that defines the carrying capacity of a harbor. The model would be based upon a risk assessment analysis, as its guiding parameter. The stated risk could be the number of serious boating accidents per year that can be tolerated. Another risk option could be at what point does significant economic impact occur and commercial vessel owner/operators will no longer enter the port due to a perceived liability threat from the large number of recreational boats vying for the same limited water space. The model could also be based upon other "risks" as well, dependent on the community's interests. An example of some secondary input parameters for the forecast model are: number of existing boats and vessels, size and types of boats and vessels, location of various docking facilities, shipping channel location, bathymetry of harbor, projected increase or decrease in commercial traffic, and relative use of waterways as a function of time of day and/or day of week. Again, secondary input parameters would be based in large part on the community's interests.

There are advantages in utilizing a model for defining the carrying capacity of a harbor. One advantage of the model is that it can establish a consensual database, which will provide the foundation to evaluate the impact of development proposals. A model can assist in the formulation of new procedures for making collective decisions. The model is a tool that has the inherent flexibility and responsiveness to be updated quickly as changes in input parameters occur, or as new results are obtained based on particular decisions. A model is also an analytical tool, which by its very nature, is more objective than the apparently random decision making processes that currently occurs within local, state and federal agencies in evaluating the impacts of a development proposal.

A model applied to such difficult questions as defining the carrying capacity of a harbor is the only effective way to analyze this problem in terms of cost, ease of implementation, time and politically acceptability. The model will also, through its objective and analytical approach be applicable to a broad range of interest groups that would include, but not be limited to: local, state and federal permitting agencies, U.S. Coast Guard, harbormasters, local planning departments, development proponents, public interest groups, shipping associations and marina owner/operators.

The present status quo of either assuming that there is not a problem or dealing with each development proposal as it comes forward without looking at the broader implications of the proposal and assessing it from a more wholistic approach can not continue without serious repercussions. Only by being proactive and developing a management plan that utilizes objective and analytical tools (i.e. computer modeling techniques) will an urban community effectively and efficiently ensure that any development that does take place will be responsive to the safe, enjoyable and profitable use of the waterways by all its users.

Changing Infrastructure of an Urban Waterfront: The South Boston Flats 1863-1920

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The onset of the Industrial Revolution in the early nineteenth century gave prominence to the northeastern United States. Massachusetts, with its flourishing mills and inundation of immigrant labor was the most intensively organized state in the region. It was primarily through the port of Boston that this region secured its raw materials and distributed its products (see Figure 1).

This paper examines waterfront changes in the South Boston Flats from its initial phase of development (See Figure 2) around 1863, up to 1920 (see Figure 3), when the Port of Boston became one of the three most important ports in total foreign commerce.

By the middle of the nineteenth century the use of the port facilities had virtually reached its capacity, while industrially the area was still growing at a rapid pace. In order to provide more effectively for the expanding waterborne commerce of Boston, the "Plan of 1866" was adopted by the Legislature of Massachusetts after many years of study.

The plan was an outgrowth of an 1861 suggestion from the United States Commission on Boston Harbor that the South Boston Flats be partly enclosed on the northeast and northwest sides by a sea wall or quay.[1] The purpose of the proposed structure was to prevent the premature dispersion of the stream from the South Bay through Fort Point Channel which could threaten the flow and margin of the main ship channel. This suggestion did not include reclamation of the enclosed areas. However, in 1863, after further study, the commissioners began using the term "occupation", and proposed the transfer of tide water from the South Boston Flats to more interior basins.[2] The"Plan of 1866" showed only the extent and outline of the fill, walls, and channels. It did not dictate the laws of land-use at the flats.

The project was primarily for harbor improvement. The wall was intended to affect certain changes in the tidal currents, as well as to retain the material dredged from the harbor. The modifications in the flow of the currents induced by the wall was intended in part to secure the permanence of the improved main channel. The Resolve of 1866, which replaced the U.S. Commission on Boston Harbor with the State Board of Harbor Commissioners, first committed the subject of the flats to that Board. In the resolve were these words: "In all plans and proposals submitted by them, always regarding the protection and improvement of the harbor of Boston is of paramount importance in any intended occupation of said flats."[3] With overall harbor improvement as the paramount project, the Board of Commissioners undertook the work with two purposes: improvement of tidal currents and reclamation.

Realizing the reclamation could not be taken as a single project, the whole territory was divided into three sections. The first section extended from Fort Point Channel to a line drawn form the foot of E Street, in the easterly line of E Street to Slate Ledge Buoy and comprised 341 acres. The second section extended 3400 feet easterly from section one's terminating point and contained 301 acres. The third and final section extended easterly from the second section to South Boston Point and had an area of 283 acres. The entire area of the three sections comprised 925 acres.

The material to fill these lands came predominantly from dredging the main channel.[4] The dredging would increase the ship channel to about 2400 feet in width, deepen it to 23 feet, and add about 174 acres to the anchorage area for heavy ships. As it turned out, material obtained from the harbor proved to be four-fifths the cost of that from the countryside.[5]

With the goal of obtaining full control for purposes of reclamation, provision was made in Chapter 446 of the Acts of 1866 for the purchase of the rights of all parties in the flats along the South Boston shore as far east as the easterly line of E Street. Viewing the work at South Boston as a great public harbor improvement, which was its primary object, the Massachusetts Legislature determined that the acquisition and control of these flats was a necessary step in the execution of landfall. The Legislature felt that the right to take property should be invoked to aid the project. They did, however, provide for compensation to the title holders of the land to be taken by the state.

In 1867 and 1868 the plan adopted in 1866 was slightly modified by the Board of Harbor Commissioners. The plan for a "contains sea wall," that was to be built as part of the "Plan of 1866," was modified to leave openings in the wall, wherever they might be needed for docks and slips.[6]

With the passage of Chapter 326 of the Acts of 1868, the Harbor Commissioners received the authority to contract with any person or with the City of Boston for the filling of the South Boston Flats. This Act also approved contracting for building wharves, docks, sea walls, basins, streets, bridges, and sewers, and for dredging near the site of the flats. In lieu of payment the contractors received either unfilled flats, or a portion of those flats that were included in their contract.

For the most part, contracts for construction and reclamation went to railroad companies, for railroads controlled most of the area adjacent to the South Boston Flats. Since these railroads were the most influential abutters of this area, by common law they exerted a great deal of control over the area through their riparian rights. Riparian rights are the rights under the law of owners of land containing a watercourse or bounded by one, to its banks, bed and waters.

The nineteenth century was the railroad era in the United States. These monolithic companies held great power, controlled much of the wealth, and owned considerable amounts of land throughout the country. Since several railroad companies owned land along the Boston waterfront, the evolution of the reclamation and construction of these flats follows the history of the conflicts between and among these commercial giants, the City of Boston, and the Commonwealth. In addition, the factors affecting change of these flats were government regulations, technology and financing.

The Commonwealth began reclamation in the area of the South Boston Flats near the junction of the Fort Point and Main channels known as the "twenty-five acre piece." The area reclaimed, measured within the outer edges of the retaining walls, was 20.64 acres. Construction of a dock added an additional 3.67 acres. Hence, the name the "twenty-five acre piece."[7] It was the first part of the flats to be filled. In 1867 this site was a slough overgrown with sea grass visible at lowest tides. Due to bankruptcy and other problems however, it took more that ten years for this parcel to be filled, it wasn't completed until 1878.

In 1869 the Board of Harbor Commissioners, with the approval of the Governor and Council, sold this plot to the Boston, Hartford and Erie Railroad Company for $545,505 (fifty cents per square foot). Later that same year approximately fifty acres of the flats, located just east of the twenty-five acre piece, was purchased from the Commonwealth by the Boston and Albany Railroad Company at twenty cents per square foot. Both of these transactions occurred under the authority of the Acts of 1869.

By chapter 260 of the Acts of 1880 the Great and General Court of Massachusetts granted authority to the New York and New England Railroad Company to buy the twenty-five acre parcel for one million dollars. During that same year the Boston and Albany Railroad Company, the original purchaser of an adjacent fifty acre lot, assigned all its rights to this lot to the New York and New England Railroad. With reclamation proceeding, by 1910 land and flats at South Boston had been significantly developed and many improvements made. At that time, the total tidewater frontage was 6,925 feet or 1.31 miles.[8]

The Board of Harbor and Land Commissioners, with the approval of the Governor and Council, had the responsibility of overseeing all geographic projects in the Port of Boston. Contracts for wharf construction went to private construction firms.

As mentioned, railroads played an important role in the development of the South Boston Flats. The New York, New Haven, and Hartford Railroad and the Commonwealth of Massachusetts were the largest owners of waterfront property there. However, in the very beginning of the landfill project, several smaller railroad companies also owned land at the flats. Some of these railroads were financially unable to fill their parcels or begin construction, thus creating time delays in the project.

Legal struggles between the Commonwealth and the various railroad companies became commonplace. May court confrontations were settled by legislative act. The Great and General Court of Massachusetts issued decrees or acts which forced the landowners to comply with landfilling deadlines. Those unalbe to comply were required to liquidate their holdings.

The transactions between and among the Boston, Hartford, and Erie, the Boston and Albany, and the New York and New England Railroad Companies and the Commonwealth complicated and delayed the reclamation and construction in this area for over twenty years. The twenty-five acre piece, and the abutting fifty and twelve acre parcels ultimately were controlled by one owner late in the 1880's. Deeds of these three parcels were given to the New York and New England Railroad Company in 1889, with the consent of the Board of Harbor and Land Commissioners.

The necessity for access to the Commonwealth's flats in addition to Congress Street, was recognized by the state as early as 1866. The construction of Northern Avenue north of Congress Street, and a bridge connecting the city proper and the South Boston Flats, was contemplated in 1873 under an agreement by the terms by which the Commonwealth, the City of Boston, the Boston Wharf Company, and the Boston and Albany Railroad Company were to begin the development of the territory known as the South Boston Flats.[9] In 1901, by chapter 507 of the Acts of that year, this avenue was laid out, with the provision that the Act would be accepted by the City Council of Boston.

The city failed to accept this act and in 1903, the Commissioners again urged action by the Legislature. This resulted in the passage of Chapter 381, Acts of 1903, which provided for the design and construction of Northern Avenue and a bridge across Fort Point Channel. Provisions for a street to connect Northern Avenue with Congress Street were also made by this act. The state would pay Boston $260,000 in partial payment of the cost of this work. By 1908, the bridge was opened to travel, and Northern Avenue was partially completed to a point 450 feet east of the east line of Pier 6, the Boston Fish Market pier.

A means of direct access to this large territory, adequate to its utilization as a terminal for maritime and railroad purposes was many years in coming. The delay can be attributed to a great extent to the conflicting land use ideas of the railroad companies and the City of Boston.

CONCLUSIONS

The need for a landfill project for the Port of Boston was readily recognized by the middle of the 18th century. The South Boston Flats project, as outlined in the "plan of 1866," called for filling in the South Boston flats. This helped the Port of Boston respond quickly to emerging shipping and trade opportunities in both foreign and domestic markets. The landfilling provided Boston not only with more waterfront space, but also with a place to dispose of future dredged materials.

By 1918 the South Boston Flats were reaping economic rewards for the state of Massachusetts through significantly increased trade with Europe. This was due to good business management in addition to its natural geographic advantage over most of the other U.S. ports. For example, Massachusetts ranked third in total foreign commerce in the United States in 1918. It ranked second in imports, and seventh in export goods at that time.[10]

Boston's decline as a port can be tied directly to the railroads and their freight rates.[11] Boston's primary freight hinterland was New England. The only serious competition for this region's commerce was New York City. The competition between these ports, however, was fierce, owing to the import commodity rates between New York and various points along the respective routes. These rates, which were more favorable to New York than to Boston, were set by the railroads.

In addition to New England, Boston had what was termed "differential" territory or hinterland which was comprised of the area west of Buffalo and Pittsburgh, east of the Mississippi River, and north of the Ohio River. However, competition for the freight from this region included Montreal, Philadelphia, and Baltimore in addition to New York City.

After the rate wars of the 1870's, the railroads serving the North Atlantic ports arbitrated the question of rates between these ports and the "differential" territory for which they were competing. The Board of Arbitration found that Boston and New York had equal ocean rates to Liverpool, the major European port at the time as well as to other foreign ports; and determined that both Boston and New York had rates lower than Philadelphia and Baltimore. Therefore, the Board adjusted the rail rate on the principal import and export commodities from Chicago, the focal point port for the differential territories to Boston and New York. The rate was set 40 cents per ton higher than the rate to Philadelphia and 60 cents per ton higher than to Baltimore.

The purpose of these rate changes was the equalization of through costs from Chicago to Liverpool or any foreign destination. As the rates between Boston and other points in the differential territory were based on the Chicago rate, that "differential" was communicated to the entire territory.

Throughout the 1890s and early 1900s Boston's advantages in ocean rates had disappeared. Import ocean rates between North European ports and North Atlantic ports had been equalized by 1910. Nonetheless, the Interstate Commerce Commissioner had reaffirmed the differential rates three times by 1912. Consequently, Boston was handicapped in its competition for the differential territory by precisely the amount of the inland differential rate imposed by the Interstate Commerce Commission.

This handicap severely hindered the Port of Boston in its efforts to gain a larger quota of western exports, primarily grain. The year 1912 was the beginning of the end for Boston in its attempt to expand its market for more traffic in this "differential" territory.

Perhaps it was less than favorable shipping charges, imposed by the Interstate Commerce Commission, which proved to be the downfall of the Port of Boston following the era covered in this paper. Although Boston had attained prominent port status in America between 1911 and 1920, it lost much of its port revenue to other seaports during the 1920s.[12] A shipping pattern had emerged by the 1920's whereby Boston became the choice port of call for ships to unload their cargo, mainly because of the region's demand for raw materials. Without exports sufficient for shippers to fill their hulls, however, ships headed to other ports to unload their remaining cargo and take on exports for return trips abroad.[13,14]

Selected References

[1]Massachusetts, Harbor and Land Commission, Annual Report, Public Document No. 11, January 1885.

[2]Raymond, Major Charles W., "Report on boston Harbor" in: Massachusetts, Harbor and Land Commission, Annual Report, Public Document No. 11, January, 1885.

[3]Massachusetts, Harbor Commission, Annual Report, House Document No. 75, January, 1876.

[4]Massachusetts, Harbor Commission, Annual report, House Document No. 10, January 1868.

[5]Massachusetts, Harbor Commission, Annual Report, House Document No. 75, January, 1876.

[6]Massachusetts, Harbor Commission, Annual Report, House Document No. 65, January, 1873.

[7]Massachusetts, Harbor Commission, Annual Report, Public Document No. 33, January, 1878.

[8]Massachusetts, Harbor and Lan Commission, Annual Report, Public Document No. 11, January 1908.

[9]Massachusetts, Harbor Commission, Annual Report, House Document No. 65, January, 1874.

[10]Massachusetts, Waterways and Public Lands Commission, annual Convention Report, September, 1918.

[11]Massachusetts, Directors of the Port of Boston, Annual Report, Public Document No. 94, January 1913.

[12]Massachusetts, Department of Public Works Division of Waterways and Public Lands, Annual Report, November, 1920.

[13]Boston Redevelopment Authority, Research Department, "The Port of Boston", White Paper Report, 1985.

[14]Perkins, Gregory W., "Boston Waterfront: A Storied Past and a Brightening Future." Boston Redevelopment Authority, Research Department, White Paper Report, 1986.

[15]Research supported by the Richard King Mellon Foundation and the Coastal Research Center of the Woods Hold Oceanographic Institution. WHOI Contribution No. 6922.

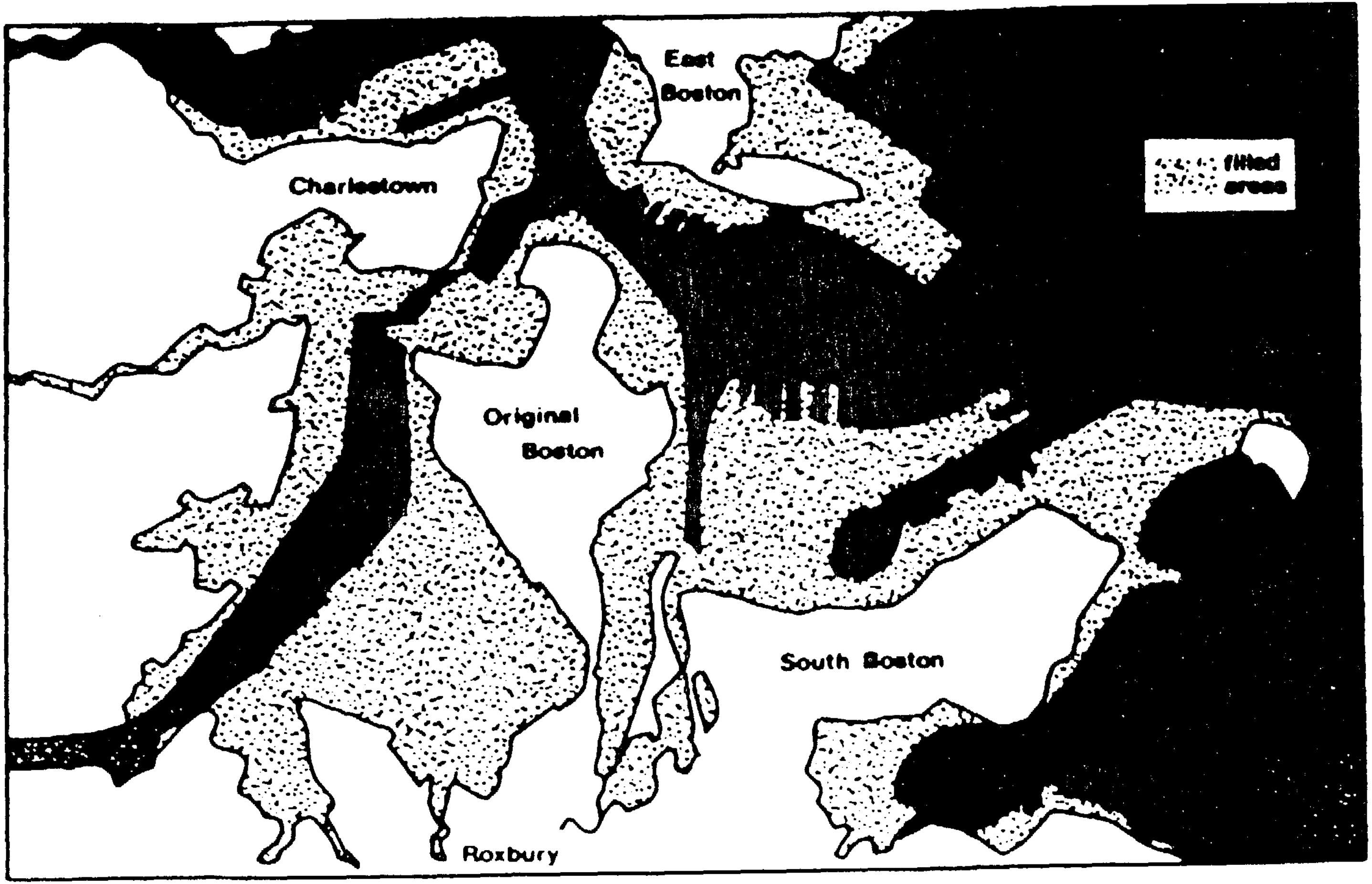
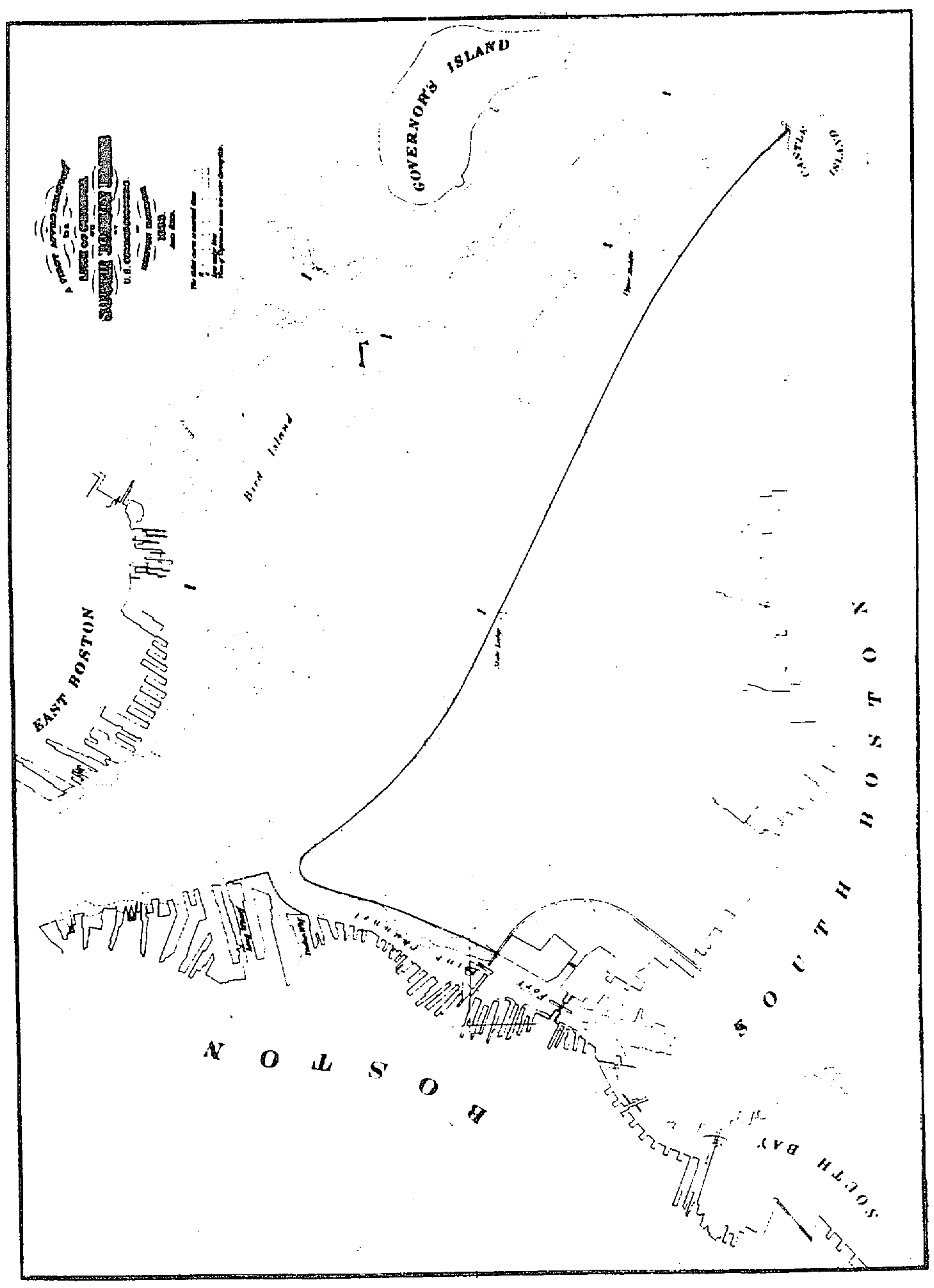


Figure 1
"Filled Areas of Boston"

Figure 2
"Line of Seawall for Filling"



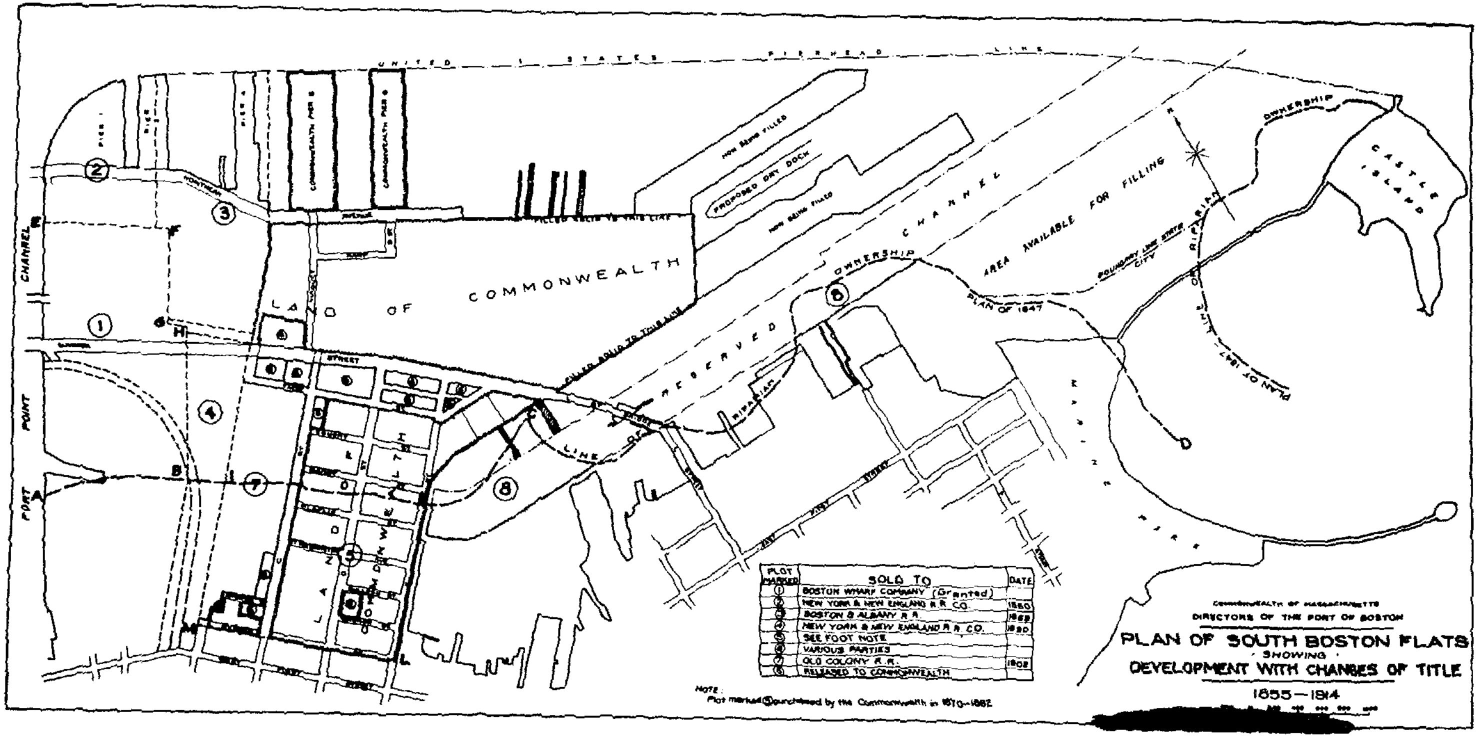


Figure 3
"Plan of Flats by 1915"

The Absence and Presence of the Systems Approach in the Restoration of Calcutta Port

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ABSTRACT

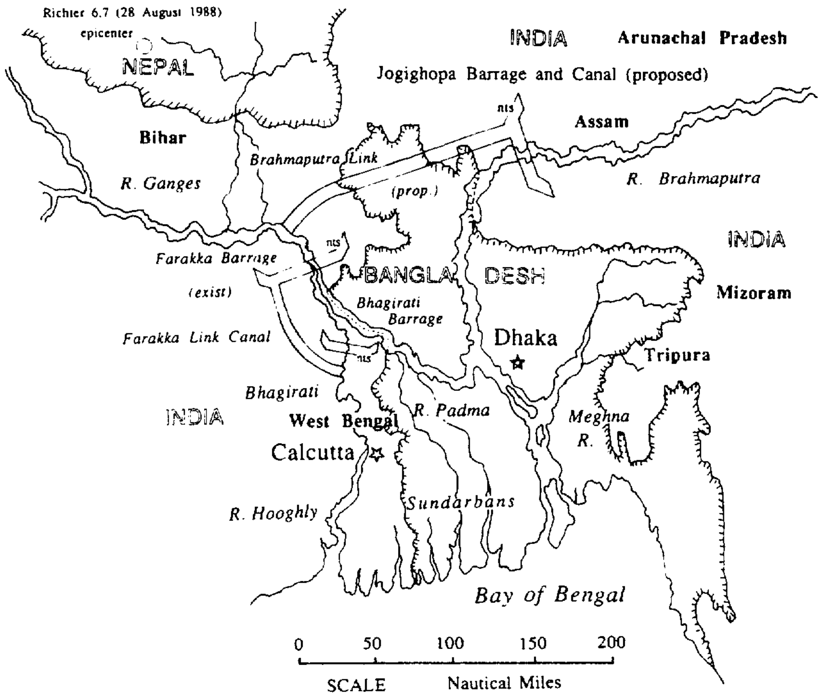
Calcutta Port is situated on the River Hooghly, a largely- abandoned distributary of the Ganges. In an attempt to reduce port sedimentation, the "Farakka Scheme"—a major interbasin transfer project—was implemented in 1975, and now no less than 40% of the lowflow Ganges is redirected to the Hooghly. But the externalities of that project—which primarily benefits India— are being disproportionately borne by Bangladesh, the lower riparian. These include the salinization of several important estuaries in Bangladesh's southwestern districts, resulting in serious ecological impacts and strained Indo-Bangladeshi relations.

The "systems approach" describes an optimizing planning mode that can be narrowly or broadly applied to water project design. New proposals for development and management of water resources in the Ganges-Brahmaputra basin provide opportunity to overcome Farakka's technical and conceptual defects.

Reversing siltation through manipulation of local hydrology is an unorthodox but sometimes practicable route toward "port renewal". Inter-basin transfer ("IBT") projects induce scouring by enhancing sediment transport capacity. In the case of threatened ports on strongly-tidal estuaries subjected to reduced freshwater inflows, IBT augmentation of river discharge can reverse the accumulation of marine sands borne upstream by flood tides and no longer resuspended by the weakened ebbs.

The use of physical and mathematical (i.e., computer) models has become essential to the design of "desilting hydraulic regimes." But the hydrography of shoaling is not yet a perfect predictive science, and a seemingly well-Planned IBT-based port-restoration may prove a fiasco, total or partial. Even if the antisedimentation component functions as intended, unforeseen "externalities" can render the project a micro success in the context of a macro disaster! Arguably, any design is misconceived and mismanaged if it releases a cascade of unplanned—and therefore unmitigated—social, political, and ecological catastrophes.

At the base of the "technological pyramid" India, with its bullock carts and its pre-industrial agrosystems, certainly lumbers behind the West, but at the apex of that pyramid, India's science and engineering capabilities are world- class (Lydon, 1987). Large scale programs of river development and water management have figured very prominently in India's movement toward self reliance, and unlike most other industrializing countries, India is dependant neither on foreign expertise nor on foreign capitalization to design and construct her hydropower, irrigation, an navigation projects. India launches her own satellites, processes her own telemetry, and draws her own conclusions as to the state of her natural resources and the trend of their exploitation. Historically, India planned and implemented large-scale engineering works pursuant only to her own criteria of acceptable ecological and social impacts, predicated only upon purely domestic cost/benefit equations.



The Port of Calcutta is India's second-largest seaport and her principal link to East and Southeast Asia. The Calcutta docks lie C. 100 km inland from the Bay of Bengal along the Hooghly River, a distributary of the Ganges. By the mid Nineteenth Century, Calcutta was the second-greatest city—in both wealth and population—of the entire British Empire. Today, it;s India's largest metropolis, with about ten million inhabitants.

Almost perfectly coincident with the rise of Calcutta has been the near complete abandonment—by the mainstem Ganges—of the Hooghly and its upbasin feeder streams. Since the 1830's, the largest part of the Ganges' discharge has flowed to the Bay of Bengal through its easternmost distributaries, bypassing much of the extreme southwest delta. Thereafter, the Hooghly received only a relatively-small component of the peak monsoon flow from the upper catchment, and virtually none of the dry-season flow.

Thus, the Hooghly sub-watershed came to be known as "the moribund delta". With the sharp decline in streamflow throughout this part of the distributary web, agriculture and local water transport systems were devastated. Many a district of low-lying western Bengal, previously prosperous, its soils annually replenished by upbasin silts delivered by the monsoon floods, and formerly well- drained (because peak flows from the mainstem theretofore kept the primary channels deeply-scoured and topographically lower than the backswamp ricelands), became depopulated, miasmic, and malarial; a nightmare for Raj administrators (Nandi, 1948). Hooghly river pilots came to have their own nightmares; the channel was increasingly obstructed by everchanging shoals and strewn with wrecks. The loss of life was phenomenal, as a visit today to Calcutta's old British cemeteries will attest. For 150 years, coping with the material and social consequences of the region's dynamic fluvial geomorphology has absorbed the best efforts of British and Indian engineers, planners, and public health officials. (And eventually, of their Pakistani and Bangladeshi counterparts.)

In 1948, a dockworker's strike that effectively shut down Calcutta Port for three months radically disrupted agriculture, manufacturing and shipping throughout eastern and northern India. This was a harbinger of what would happen to the regional economy if the operation of the Port was foreclosed more permanently by Nature, a process that was then already well underway.

In 1975, India put into operation the Farakka Barrage and Canal, to increase the freshwater flow of the Hooghly by 40.444 cusecs. The principal structures included a low dam across the mainstem Ganges, nearly 3 km in length; a 27 km diversion canal; and a ungated afterbay barrage across the Bhagirati River, just above canal's outlet. (The Bhagirati is an upper arm of the Hooghly.) Apparently, the project has been successful in stabilizing (or even reversing) the siltation of Calcutta Port, the ostensible primary objective. (In the last five years, the depth of the Hooghly channel increased by c. 1 M.) The Farakka scheme also secured Calcutta's municipal freshwater supply, which had been severely threatened by salinization.

Prior to implementation of the Farakkak project, monsoon high flows were divided between the east and west delta distributaries: approximately 30% of the Ganges' aggregate monsoon discharge was delivered to the Bay of Bengal through India, via the channels of the Bhagirati/Hooghly. But because the Bhagirati barrage precludes passage of appreciable floodflows, the entire flood peak is now diverted to Bangladesh (via the Padma, the easternmost mainstem Ganges channel). Accordingly, ordinary peak floodflows inside Bangladesh have risen by about the same 30% (from c. 1,100,000 cusecs pre- Farakka, to c. 1,500,000 cusecs post-Farakka). Additionally, the reduction of lean season flow in the main Padma channel could itself be expected to produce some degree of aggradation (i.e., deposition on the channel floor). Any elevation of the Padma's bed would exacerbate problems of drainage and flooding, even if peak discharges were not also being increased, as they are.

But if heightened flooding can only tentatively be attributed to Farakka, there is no doubt whatever that Farakka has worsened downbasin drought during April and May: the mean lowflow discharge of the lower Ganges had been c. 70,000 cusecs, and for most of this century (before Farakka), the Bhagirati's natural offtakes were usually closed by sandbars during the dry season Thus, 5,000 cusecs, of less, of the leanflow Ganges' waters had ordinarily entered the Hooghly via the Bhagirati. Accordingly, at least 65,000 cusecs had continued on downbasin to Bangladesh. With the Farakka project in operation, as much as 40,000 cusecs (of the original 70,000) can be—and has been—diverted to the Indian states of Bihar and West Bengal.

Since commissioning Farakka, the minimum flow released to Bangladesh during the driest weeks of April has been as low as 23,000 cusecs, and has averaged only c. 35,000 cusecs. This represents a *40% reduction* of absolute minimum streamflows delivered to the lower riparian, compared to the years 1964 through 1974. Not surprisingly, Bangladesh—which receives no benefits whatever from the project—has objected vigorously to every aspect of the Farakka scheme (Nazem and Kabir, 1986).

The "Green Revolution"—irrigating fields to raise two of three crops per year (instead of one), plus the use of hybrid of high- yielding-variety seeds and synthetic pesticides and fertilizers— has enabled India to become completely self-sufficient in food grains. But the greatest production gains have been made in the wheatgrowing districts of the north; the extension of irrigation to the deltaic eastern region—the Subcontinent's "rice bowl"— was much slower. (In part, this was because the conventional bureaucratic wisdom—distantly headquarted in New Delhi or Islamabad, the capitals, respectively, of British India, and Post-Raj Pakistan—had always perceived the problem in Bengal as "too much water, rather then too little.") Unlike India, Bangladesh is 15-20% dependant on imported cereals, and the populations of both countries continue growing at rates that project a doubling in 25 years. (The present population density of the Ganges Delta—nearly 1,000 persons per sq. km—is already the highest in rural Asia.)

But there remains one larger uninhabited tract: covering the Delta's saltier southwestern reaches is the greatest mangrove forest on earth, 800,000 ha. of dense swamp—penetrated, drained, reticulated, flooded by an arterial maze of brackish channels; from windblown, tidal estuaries—former mainstem distributaries so wide that the far shore is barely visible in daylight—to meandering muddy creeks, winding almost like caverns through a contiguous evergreen canopy, some trees as tall as 30m. This is the Sundarbans, "beautiful forest" in Bengali: island domain—even today—of hundreds of Royal Bengal Tigers, and haunt of their primary prey: spotted deer, feral pigs, rhesus macaque. (Their secondary prey is an unlucky sixty or so persons mauled to death each year, and sometime dragged away and eaten; the inevitable casualties among the army of temporary residents: Fisherman, woodchoppers, honey gatherers, and thatch cutters.)

To the handful of tourists who gain entry, the Sundarbans is still a beautiful forest. Herons, kingfishers and whitefronted eagles are common, as are fresh tracks of the elusive, semi- aquatic tiger (Blower, 1985). Though serving as habitat for one- fourth of all Asia's remaining wild tigers, the Sundarbans is a wilderness, but a strictly controlled and scientifically managed reserve since the mid-Nineteenth Century, yielding a rich and heretofore- sustainable stream of woodland and fisheries products, the extraction of which provides direct employment for a half-million Bangladeshis, and food, fuel, and fibre for scores of millions more.

In 1983-84, a comprehensive inventory of the Sundarbans was conducted by the U.K.'s Overseas Development Agency (ODA). (The previous complete survey was done in the mid-1950's). The final report, while modest about its own ecological depth, emphasized that compared to its condition three decades before, much of the forest was in a general state of decline, with more severe collapse evidenced locally (Chaffey et. al.,1985).

The most desirable and robust mangrove species, *Heritiera fomes (=H. minor)*, "shundari", prized for its quality timber and its excellent fuelwood, was being replaced on many sites by *Excoecaria agallocha*, "gewa", a much less valuable newsprint tree with greater salinity tolerance. On a good portion of sites where shundari still remained, many trees were obviously stunted (the "top dying" syndrome), and nearly everywhere that H. fomes was still the dominant species, the canopy was scrubbier and more open than seen in the 1950's. Altogether, the standing crop of harvestable wood was very much lower than had been calculated; the previous estimate, wildly incorrect, had been projected forward from rate-of-growth and timber yield data collected by professional foresters since the height of the Raj.

While the ODA surmised that the reduced stocking of shundari was caused in part by petty tree poaching of possibly, by larger- scale corrupt practices (so that the actual timber volume annually extracted exceeded the authorized and recorded cut), their report concluded that to a degree as yet unascertained, the decline of the shundari forest was "almost certainly caused by a major recent alteration of the regional hydrological regime."

The circumstantial evidence certainly points toward Farakka. Although India and Bangladesh have negotiated several short-term treaties that somewhat more equitably allocated the low-flow Ganges (the last of which expired in October 1988, and which the Indians have refused so far to re-extend), the only point of complete agreement between the two nations is that the *present supply is altogether insufficient to meet the present demand!* Given the demographic, hydrological, and political realities, it is extremely unlikely that India would (or could) appreciably curtail the Farakka diversions.

At least three alternative routes toward augmenting the Ganges' lean season discharge have been proposed: The Indians argue that the solution lies in building yet another massive barrage and interbasin transfer scheme, this one to deliver 100,000 cusecs of water from the Brahmaputra River through a new 300 km trans-delta canal that would originate at Jogighopa, Assam (the prospective barrage site), and would terminate in Bihar, just upstream of the Farakka offtakes. The Bangladeshis have ruled this plan "altogether unacceptable" for many of the same reason -political and technical- for which they've been opposed to Farakka, and not least because the "Brahmaputra Link" would give India total (and unilateral) control over both of the great rivers (Abbas, 1982).

The Bangladesh counter-proposal would create a system of new monsoon storage reservoirs to be impounded behind high dams in the mountains of Nepal. (About 45% of the Ganges' annual flow originates in the Nepali portion of the watershed.) In addition to an aggregate flow augmentation of up to 130,000 cusecs enabled by such reservoirs, an enormous amount of marketable hydropower would also be generated. At present, 90% of Nepal's total energy supply is yielded by biomass fuels; her forests are already mostly cut, and her demographic situations nearly identical to those of India and Bangladesh. According to the proponents of this scenario, Nepal—having no natural resources whatever, apart from her undeveloped hydropower potential—should *leap* at the opportunity to have the dams built. But every possible reservoir site in Nepal entails inundation of existing villages, the population of which would almost certainly end up being scattered an urbanized. With the Terai lowlands now largely cleared and homesteaded (the wave of settlement began there in the 1960's, following the suppression of malaria), there no longer exists and real option to relocate whole communities in the countryside.

The third perspective—with its chief proponents in universities and donor agencies—calls for the accelerated development of *subterranean*, rather than surface water resources (see Lydon, 1987 for the perspectives of Roger Revelle and Paul Jones). Predicated on a highly speculative analysis of regional geohydrology, their view is that the voluminous groundwaters transiting the deep alluvial strata underlying the Gangetic Plain could be practicably exploited. Wells might have to be drilled to extraordinary depths—far deeper than ordinarily penetrated of water—but the lowermost aquifers are—theoretically- - sufficiently artisan as to require little, if any, supplemental pumping. Thus, the energy costs of raising water to the surface—the usual bugaboo of deep- aquifer tubewells—should be almost negligible. (Pumping water from shallower wells in the non- artisan surficial aquifers could be practical if "cheap hydropower" was provided by Himalayan dams.) "Conjunctive use" of existing surface water supplies and probable sources of groundwater would effectively double or triple overall water availability during the five driest months.

In terms of implementation, (or even in terms of *preliminary* engineering and economic analysis) all three courses have essentially gotten nowhere: The groundwater alternative remains completely hypothetical until extensive geological research is performed. The World Bank has reportedly signaled its willingness to finance the requisite test drilling, but India and Bangladesh both appear unreceptive: Possibly because they fear a weakening of their bargaining positions in the Ganges allocation dispute if large-scale groundwater reserves were empirically verified. (Uncertainty has its uses!)

India still argues that the Brahmaputra Link is the proper solution, and that the Bangladeshi program for monsoon storage in the Himalayas could be "incorporated" into their Brahmaputra initiative. But the new reservoirs would be located not in Nepal, on tributaries of the Ganges, but in northeast India, within the catchments of the Brahmaputra and the Meghna Rivers. (And the Indians also note that the high dam construction would be a "supplementary" component; to be initiated "sometime in the future", *after* the Jogighopa Barrage and the interbasin transfer canal were built and in full operation.)

Two events occurred in mid-1988 that greatly increased world attention to natural hazards in the Ganges/Brahmaputra region: the first was extraordinarily heavy monsoon flooding, "The worst in memory", in Assam and Bangladesh (of which fully two-thirds was under water). At least 4,000 drowned, tens of million were rendered homeless, and critical food and seed stocks were everywhere ruined, suggesting that the *real* crises would arrive some months later. The context of the ongoing water management discourse—such as it was—shifted abruptly from drought alleviation to flood protection and prevention. Indo Bangladeshi relations took a sharp turn for the worse; the Bangladeshis blaming the problem on India generally and on Farakka particularly. The semicontrolled Dhaka press was flamingly intemperate, and Bangladesh's government gratuitously angered India by rebuffing disaster assistance (FEER, 1988). The proposed Himalayan reservoirs once again became a primary topic. This time, the discussion of Brahamaputra storage in the mountains above Assam was more than academic: Some of the same Assamese who had been highly suspicious of New Delhi's previous Brahmaputra schemes probably now view the dams—and their flood- control benefits—in a different light. (And relations between Assam and the center have generally much improved since Rajiv Gandgi's 1987 promise to strongly suppress the immigration of "Bengalis"—mostly from *Bangladesh*—who were perceived, correctly, as swamping Assam's culture and landscape.)

The second was yet another natural disaster in which thousands died: the region's greatest earthquake since 1934. Epicentered about 170 km southeast of Kathmandu, and measuring Richter 6.7, the quake flattened twelve Nepali provincial towns, several of them nearby or downstream of the very sites Bangladesh had been proposing for big new Himalaylan reservoirs. (The alternative dam sites posed by India for Assam, Arunachal Pradesh, Tripura, and Mizoram were also thoroughly jolted.) Indian engineers insist that they've perfected the technique of building extremely large dams in seismically vulnerable environments, but there's been apparent disagreement over that from some of their Russian ex- colleagues.

The "systems approach" is a wonderfully flexible term: at one extreme of the spectrum of definitions (the "hard science" end), a systems approach describes a mode of rational problem-solving based on the manipulation of discrete models—physical or numerical, (i.e., computer) simulations—designed to effectively replicate certain critical aspects of the problem-at-hand. Ideally, the output of this process enables the modeler to recommend (to the planners and policy makers) the optimal "real world" course of action; an engineering design, a public policy, an educational campaign, a diplomatic initiative (Biswas, 1976).

India *did*, in fact, use such techniques; physical hydraulic models of sedimentation, and computer models of salinification, which together established the minimum-flow requirements of the Hooghly at Calcutta. By these lights, the systems approach wasn't at all "absent", as implied in the title of this paper. Determining the "conservation-flow" requirements for Bangladesh, the lower riparian, was simply not part of the problem then being modelled.

At the "softer", more epistemological extreme of that same spectrum of definitions the "systems approach" refers less to a specific cluster of methodologies than to an analytical philosophy: It holds that, by-and-large, the technical and social problems comprising the realm of planning resemble Russian dolls—lying, as they do, in nested sets of reality. An attempt to solve any problem purely on its own level, *while ignoring the likely effects of the proposed solution on the larger environment in which that problem is embedded—and vice versa*—will inevitably prove sub-optimal and misdirected. Yes, the "cure" might work in a particular narrow context, but only—if viewed more globally—at risk of worsening the disease.

The unintended destruction of the estuarine ecosystems of the southwest Ganges Delta is a externality of the rehabilitation of Calcutta's port and freshwater supply. This outcome was insufficiently considered, largely foreseeable, and possibly unnecessary. If the in-stream flow requirements of the Sundarbans were known, a proper release regime (or an appropriate structural solution) might have been applied. The question was just not posed! (Nor apparently, was seriously considered even the relatively-conventional installation of fishways of ladders to protect important migratory fisheries *above* Farakka: harvest of the shad—like *hilsa ilasha* ("hilsha")—a protein staple of the Bengal diet and formerly taken as far upriver as Haridwar, at the very foot of the Himalayas—crashed abruptly (Ctr. Sci. and Envi., 1986).

The argument is easily offered (and while incorrect, is not so easily rebutted) that "in the desperate South Asian context, ecology is a luxury". Thus, the restoration of the Sundarbans has—so far—hardly figured at all in either the allocation of the augmentation debates.

So where do we go from here? First we should note that ecological sensitivity in big water projects was scarce *everywhere* during the era that Farakka was taking shape, and that in India particularly, there has evolved since then a very credible environmental management infrastructure. Second, we should regard the collapse of the Ganges' estuarine systems as neither irreversible nor irremediable: Integrated multi-purpose and *multi-objective* river basin management is accepted in principle (at least) by all the parties to the presently-stalled negotiations—as well by the external donor community. ("Multi-objective implies that criteria other than *economic efficiency*—heretofore, the single objective which subsumed the multiple purposes—should influence prefect design.)

This does not mean that meeting the instream-flow needs of ecosystems will from now on be mandatory. Or that a visionary planning perspective will wield a technical fix for *every* externality of development.

It means that the feasibility of the ecological restoration of the Sundarbans is properly part of the present problem set. a study to determine such feasibility would provide the following outputs:

1) An explicit statement of the quantifiable and nonquantifiable benefits of a minimally-degraded southwest Ganges estuary, and of the costs of the no-action

alternative;

2) A credible estimate—spatial, temporal, and volumetric—of the "conservation flows" required to maintain those benefits; and,

3) A descriptive ranking of each of the present proposals (for reallocating existing supplies, of for lowflow-augmentation through storage, interbasin transfer, and groundwater abstraction) as a practicable supplier of instream flow needs.

But if we devised today a seemingly-wonderful program that optimized development of the region's water and energy resources while simultaneously restoring the Sundarbans, we'd still have to acknowledge that our own design might eventually prove as myopic and flawed as the Farakka project. What did we leave out of the models this time? Have we incorporated worrisome meteorological trends, including rising sea levels? The seasonal window of tropical cyclones might be opened—and their recurrence interval shortened—by only a very slight increase in the summer surface temperature of the Bay of Bengal. (Given the sensitivity of intertidal ecosystems to the stage, periodicity, chemistry, and kinetics of ordinary—as well as extraordinary—inundation cycles, a Sundarbans preservation scheme becomes *highly* problematical when all these factors may be changing at presently indeterminable rates.)

And what about demography? Another quadrupling of Bangladesh's present population—which would cram 420 million people into a flood-prone landscape about the size of California's Central Valley—seems implausible, even unimaginable. (But to Raj administrators in the early 1940's, so would have seemed the quadrupling that *has* occurred since then.)

Add a dozen other factors that we've possibly neglected, either out of ignorance, or because they'd over-complicate the modelling, of because we just don't have the data. The systems approach instructs us that when dissecting previous planning disasters, please remain wary of present delusions of grandeur.

Abbas, A.B. (1982) The Ganges Water Dispute, 2nd edition. University Press, Dhaka

Biswas, Asit K. (1976) *Mathematical modelling and water-resources decision making*, in Systems Approach to Water Management. A.K. Biswas, ed., McGraw-Hill, NY

Blower, J.H. (1985). Sundarbans Forest Inventory Project, Bangladesh: Wildlife Conservation in the Sundarbans. Overseas Development Administration Project Report 151, Land Resources Development Center, Surbiton, Surrey, U.K.

Center for Science and Environment (1986) State of India's Environment, 1984-85. New Delhi

Chaffey, D.R., F.R. Miller and J.H. Sandom (1985) A Forest Inventory of the Sundarbans, Bangladesh. Main Report, Appendices 1-15, and Maps. 5 vols. Overseas Development Administration Project Report 140, Land Resources Development Center, Surbiton, Surrey, U.K

Far Eastern Economic Review (1988) *Stemming the Flood*. FEER, 13 October, p.24

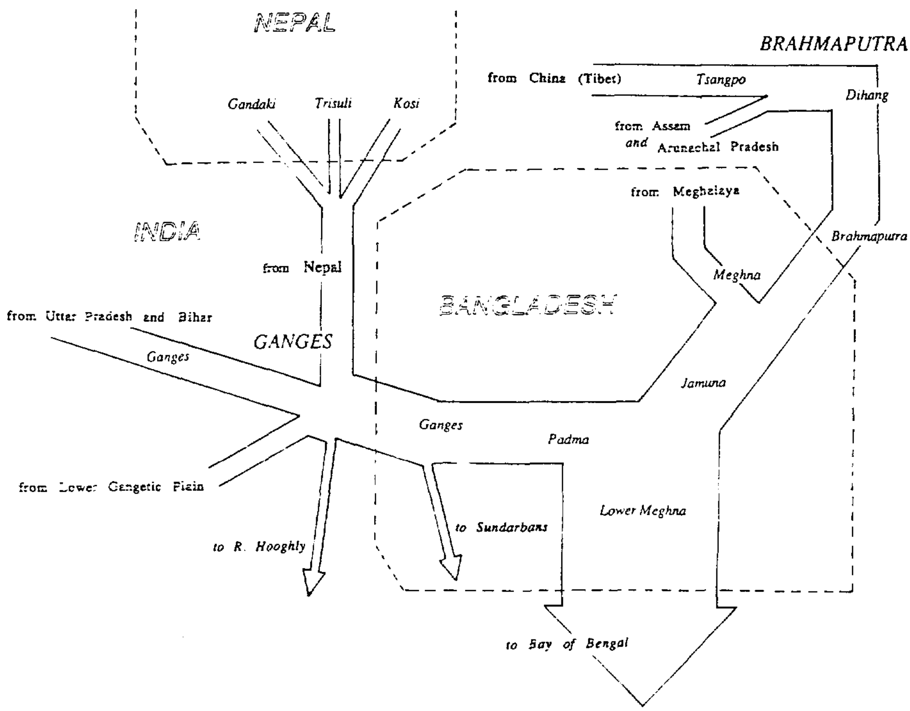
Lydon, Peter (1987) Water in the Ganges - Brahmaputra Basin: Irrigation, Flood Control, and Hydro-electricity for 400 million people. Monograph ("Discussion paper") for USAID and US Foreign Service Institute, Fairfax, VA

Nandi, S.C. (1948) Bengal Rivers and Our Economic Welfare. U. Calcutta Press

Nazem, Nurul Islam and Kabir, Md. Humayun (1986) Seminar on Indo-

Bangladesh Common Rivers and Water Diplomacy. Bangladesh Institute of International and Strategic Studies, Dhaka

Schematic Flow Diagram
Ordinary Peak Monsoon Discharge



Survey of the Capability of Smaller U.S. Ports to Implement Annex V of MARPOL

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Background

In December 1987, Congress passed the Marine Plastic Pollution Research and Control Act (MPPRCA). This law, which implements Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL), prohibits the dumping of plastic within the U.S. Exclusive Economic Zone (EEZ), restricts the disposal of other types of garbage generated on ocean vessels, and requires that adequate facilities for receiving garbage be available at all U.S. ports and terminals, including recreational marinas.

Unlike Annexes I and II of MARPOL, which regulate oil and chemical discharges from large ships, the MPPRCA applies to all U.S. flag vessels anywhere in the world, to all foreign flag vessels in the U.S. EEZ, and to all U.S. commercial, recreational, and fishing vessels of any size. In addition, the MPPRCA extends its broad reach to a wide range of ports as well as vessels. Earlier MARPOL regulations primarily affected large ports involved in international trade. But the new law also applies to smaller ports, to public and private terminals, and to public and private marinas.

How the new law will affect these smaller port entities is difficult to predict. One major concern, of course, is whether or not it will impose burdensome garbage handling costs that will foster non-compliance. According to one expert,

> The law does not stipulate anything about waste handling or disposition by the ports. This, however, is likely to be the toughest issue facing ports and terminals. They will have to negotiate with municipalities and counties for access to landfills and incinerators and may find themselves liable for incorrect handling of trash such as mixed food wastes from international vessel traffic...or hazardous wastes. Providing waste reception facilities is sure to be expensive and costs probably will be passed on to port users. (Augerot, 1988)

We conducted this survey of smaller ports in an attempt to address some of the uncertainties posed by the law. Specifically, we wanted to assess how aware smaller ports and marinas were of the proposed law and what they were doing to prepare for it.

Methods

During September 1988, we surveyed 58 smaller ports and marinas on the Atlantic and Pacific coasts and the Gulf of Mexico. We intentionally excluded from our survey the 75 ports that were involved in the 1987 membership survey by the American Association of Port Authorities because it focused primarily on large ports heavily involved in international trade. Except for that limiting criterion, the choice of ports in the survey was left to the judgment of each author. We attempted to include ports whose activities were representative of the range of activities that other smaller ports in that particular state were involved in. The survey was not intended to be a scientific sample.

We conducted the survey by telephone, using a three page questionaire. The questions were framed to elicit a response of "yes," "no," or "do not know" followed by an open-ended opportunity to elaborate. For example, "Do you think this new law will change your waste handling and disposition practices?" If the response was "yes," the respondent was asked to explain how those practices would change. (The states involved in the survey and the number of ports in each are listed in Appendix A.)

Results

Table 1 shows the number of ports contacted on each coast and their principal activities.

Coast	Total Ports	Int'l Trade	Comm'l Fish	Marine Rec	Indus/ Comm'l Dev	Cruise Ships
Atlantic	27	12	6	7	-	2
Gulf	16	7	2	1	4	2
Pacific	15	5	7	1	1	1
Total	58	24	15	9	5	5

Table 1. Principal Activity of Surveyed Ports

Fifty-seven percent of the ports in the survey took the lead role in handling garbage generated by port users. In 22 percent of the ports, a third party (i.e., terminal operator, local government, shipping agent) was responsible for all aspects of trash handling and disposal. Eight ports, representing 14 percent of the total survey, took the lead for handling garbage at the *marina operations* but delegated that responsibility in their *terminal operations* to the terminal lessees. Two ports acted as intermediaries by providing lists of waste haulers to port users, who then paid the hauler directly for garbage service. Two ports in the survey did not handle any vessel garbage.

The Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture requires that U.S. ports use approved facilities to sterilize or incinerate certain types of garbage that originate in foreign ports excluding Canada.

(This requirement is intended to prevent the spread of infectious diseases and pests that could have catastrophic impacts on domestic agricultural commodities.)

The APHIS regulations do not apply to 23 of the 58 ports in the survey because they do not handle international vessel traffic. Of the 35 ports subject to the APHIS rules, more than 50 percent (18 ports) indicated that they did not know if a USDA-approved facility was available. Only 17 percent (6 ports) had access to an approved facility while 32 percent (11 ports) knew that such a facility was not available.

The survey indicated a high degree of awareness about the MPPRCA among smaller ports. The results are shown in Table 2.

	Atlantic	Gulf	Pacific
No Awareness	11	2	2
Aware but no action	12	9	5
Aware and proactive response	4	5	8

Table 2. Familiarity of Surveyed Ports with the MPPRCA.

Forty-three of the ports (74 percent) were familiar with the MPPRCA, while 15 had no knowledge of it at all. Ports on the Atlantic Coast were the least aware of the new law with 11 of the 27 ports contacted indicating they had no knowledge of the MPPRCA. (Of those 11 ports, four are primarily involved in international trade and five in marine recreation.) Only two ports on the Gulf Coast and two on the Pacific Coast had no knowledge of the new law.

Of the 43 ports that knew about the new law, 26 had taken no action in response to its impending implementation. The other 17 had given some consideration to how the law might affect their operations. (This ranged from discussion of the law to planning to actually instituting changes.)Ports on the Pacific Coast were the most proactive in response to the MPPRCA with eight ports indicating they were planning or initiating various actions to deal with the law.

Most of the ports believed the law would not have any effect on their waste handling procedures. When asked if the MPPRCA would require a change in how their port collects and disposes of waste, only 21 percent of the ports expected that changes would be necessary. Sixty percent said no changes would be required and 19 percent did not know how the law might affect them.

In addition, 59 percent of the respondents said they would not have to enlarge their garbage collection facilities because of the new law. Twenty-two percent did not know if they would have to add more facilities, and 19 percent definitely said they would increase their garbage handling capacity to meet the requirements of the law.

If the MPPRCA regulations caused garbage handling costs to rise, half of the ports in the survey said user fees would be instituted or increased to cover them. Only 7 ports (12 percent) indicated they would absorb the cost as an additional port expense.

Discussion

While 75 percent of the smaller ports (43) in the survey were aware of the MPPRCA, only 40 percent (17) had considered how it would affect them or had taken steps to comply with it. This lack of action can be attributed to several factors. First, many of the ports have consciously adopted a wait-and-see attitude. The U.S. Coast Guard's rule-making process, originally scheduled to be completed in October 1988, was still at the public hearing stage in November 1988. Until specific regulations were known, said many respondents, any planning or action was premature.

Moreover, 60 percent of the respondents believed their current garbage handling practices would adequately handle the requirements of the new law. Whether or not that perception proves to be accurate, these ports have nothing to gain from establishing new policies and practices that may not be necessary.

Many of the ports involved in international shipping were skeptical about the MPPRCA based on their experiences with the chemical and oil waste discharge regulations of MARPOL Annexes I and II. These ports complied with the certification requirements of those annexes and then experienced no demand for the waste handling services set up to handle chemical and oil wastes. Some respondents felt the same might be true with the MPPRCA.

Finally, we found a general lack of understanding of the APHIS requirements among the surveyed ports involved in international commerce. If these regulations were more broadly known and enforced, no doubt more of the smaller ports would have to change their garbage handling and disposal programs. An educational effort to familiarize these ports with the APHIS requirements may be needed.

The proactive response of Pacific Coast ports, especially those in the Pacific Northwest and Alaska, is most likely explained by the efforts of the Highliners Association, a group of influential commercial fishermen, who began focusing attention on the non- degradable debris problem in 1985. Their efforts led to several Sea Grant conferences on the subject and a pilot demonstration project at the Port of Newport, Oregon, funded by the National Marine Fisheries Service. Moreover, many of the Alaskan ports face a difficult situation in relation to plastic debris—lack of landfill capacity, high costs for garbage disposal, and a highly visible plastic pollution problem.

Appendix A. Number of ports contacted in each state.

Atlantic Coast: Maine, 3; New Hampshire, 1; Massachusetts, 4; Rhode Island, 2; Connecticut, 2; New York, 2; New Jersey, 2; Maryland, 2; Virginia, 2; North Carolina, 2; South Carolina, 2; Georgia 1; Florida, 2.

Gulf Coast: Florida, 4; Alabama, 1; Mississippi, 3; Louisiana, 3; Texas, 5.

Pacific Coast: Alaska, 3: Washington, 4; Oregon 4; California, 4.

Bibliography

Augerot, Xanthippe. Plastic in the Ocean: What are we doing to clean it up? Washington Sea Grant Program, Seattle, Washington. 1988.

Fawcett, James A. and Michael M. Liffmann, editors. Non-Maritime Port Activities:

A Research Agenda. University of Southern California Sea Grant Program and Louisiana Sea Grant College Program. 1985.
Department of Transportation, U.S. Coast Guard. Regulations Implementing the Pollution Prevention Requirements of Annex V of MARPOL 73/78. October 27, 1988.

U.S. PORTS AND THE REGULATION OF MARINE DEBRIS POLLUTION

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U.S. Ports and the Regulation of Marine Debris Pollution

I. Description of the marine debris pollution problem

A. *Sources of marine debris pollution.* In recent years, the ecological consequences of persistent wastes that have been lost or discarded into the marine environment have become apparent. Of the various types of marine debris, plastics pose the most serious threat. The durable characteristics that make plastic so convenient for packaging, commercial fishing gear, and navigation equipment also make it a continuing, nondegradable and persistent presence in the environment.

Ocean source debris comes from commercial fishing vessels, merchant shipping vessels, offshore platforms, military and passenger vessels, and recreational and sport fishing vessels. Although recent comprehensive studies are not available, in 1975 the National Research Council, National Academy of Sciences, estimated that almost 6-1/2 million tons of trash is dumped into the oceans every year, 45,000 tons of which is plastic.[1] Studies estimate that marine commercial fisheries alone have generated as much as 150,000 tons of plastic debris.[2]

Land based sources of plastic debris include wastes from plastic manufacturing plants, overflow from municipal sewage systems, storm sewer run-off, escapements from landfills, degradation of dock and marina structures, and littering. In addition, industries that synthesize resin pellets into plastic articles are a source of marine pollution through direct discharges in the course of manufacturing.

Solid waste disposal practices also contribute to marine debris, even though outright ocean dumping of municipal solid waste was prohibited in 1974. Escapement into nearby waterways during loading and unloading, spillage from barges during transit, and illegal dumping all are means by which residential and commercial trash finds its way into oceans and waterways.

B. *The effects of marine debris pollution.* Marine debris pollution presents numerous problems, ranging from the aesthetic effects of littered beaches to the entanglement and death of marine wildlife.

The most thoroughly documented impacts of plastic marine debris are its effects on marine birds, mammals, turtles and fish.[3] Seals and sea lions appear to be most severely affected as a result of their tendency to investigate floating debris. Seals entangled in debris may become immobilized and drown, incur wounds and infections, or experience disruption in life-sustaining behavioral functions. Although the number of animals affected in these ways is unknown, the level of mortality and serious injury is believed to be significant. For example, it has been estimated that as many as 50,000 fur seals die each year from entanglement in marine debris.[4]

For birds, plastic debris poses a threat of harm from entanglement and ingestion. Birds also become entangled in monofilament fishing line and everyday domestic debris. For seabirds, small plastic pellets and fragments floating in the water may resemble food items. The effects of debris ingestion are not well understood, but may interfere with normal eating and digestion, or cause long-term physical deterioration due to malnutrition, decreased reproductive performance, and inability to maintain normal energy requirements.[5]

II. Legal requirements

There are several domestic and international legal authorities that address marine debris pollution. Two of the most important international agreements are the London Dumping Convention ("LDC"),[6] and the International Convention for the Prevention of Pollution from Ships and its 1978 Protocol ("MARPOL").[7]

The LDC, which entered into force in 1977, prohibits the dumping of plastics and other persistent synthetic materials. However, dumping is defined as "any deliberate disposal at sea,"[8] and does not include the disposal of wastes that occur incidental to vessel operations. The LDC's application to the control of plastic pollution and other debris is limited, therefore, because it applies only to waste carried to sea for the purpose of disposal.

MARPOL is more directly applicable to the problem of marine debris pollution in that it addresses the "deliberate, negligent or accidental release" of substances that may harm living resources or marine life.[9] The regulatory annexes of MARPOL address oil, chemicals, packaged hazardous substances, sewage, and garbage. Annex V, relating to marine debris (including plastics), entered into force in December 1988.

Subject to narrow exceptions, Annex V prohibits the disposal into the sea of all plastics, including synthetic ropes, fishing nets, and plastic garbage bags.[10] It also regulates the disposal of other refuse. Floatable dunnage, lining and packing materials may not be disposed of within 25 nautical miles of the nearest land, and disposal of food wastes and all other garbage is prohibited within 12 nautical miles.[11] "Garbage" is defined as "all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically. . . ."[12]

The prohibitions apply to all ships and to offshore platforms used in mineral activities. Of particular interest to ports is the requirement that governments party to MARPOL "undertake to ensure the provision of facilities at ports and terminals for the reception of garbage, without causing undue delay to ships, and according to the needs of the ships using them."[13]

To aid compliance with Annex V, the Marine Environment Protection Committee of the International Maritime Organization ("IMO"), the body which administers MARPOL, has developed technical guidelines for ports.[14] The guidelines assist ports in determining whether their facilities are adequate, and encourage studies on reception facilities and disposal technology.[15] Factors used to determine the adequacy of facilities include the needs of each type of ship using the port, the number and types of ships using the port, and the size and location of the port. Detailed formulae are available for calculating the types and amounts of garbage likely to be generated by vessels.[16] The guidelines also urge party states, "at the earliest opportunity," to initiate studies of the adequacy of port facilities and to consider alternatives appropriate to each particular port.[17] Although the nations party to MARPOL may establish different regulations to govern port facilities, it is certain that waste handling facilities will come under careful international scrutiny.

As is true for international legal authorities, there are several United States laws that apply to the marine debris problem. These include the Refuse Act of 1899,[18] which prohibits the disposal of refuse into U.S. navigable waters or the three mile territorial sea, the Marine Protection, Research and Sanctuaries Act,[19] which implements the LDC and is concerned with ocean dumping, and the Clean Water Act,[20] which regulates pollutant discharges from point sources. In addition to these statutes, at the end of 1988 a new domestic law dealing exclusively with this issue came into effect. This law, the Marine Plastic Pollution Research and Control Act ("MPPRCA"), implements Annex V domestically and regulates ports and terminals in the United States, as well as the vessels that they serve.[21]

Under the MPPRCA, Annex V applies to U.S. ships anywhere they are located,[22] and to foreign ships in U.S. navigable waters and the U.S. Exclusive Economic Zone.[23] Given the broad scope of the definition of the term "ship," the MPPRCA applies to virtually all watercraft, including recreational boats. Warships, naval auxiliary vessels, and other noncommercial ships operated by the United States are exempt until 1992.[24]

In addition to implementing Annex V, the MPPRCA establishes additional restrictions. By December 30, 1989, the Secretary of Transporation must promulgate regulations that require certain ships to maintain refuse record books and shipboard waste management plans and to display placards describing Annex V prohibitions.[25] The importance of this requirement, which is intended to assist in enforcement and improve the waste management planning practices of ships, is highlighted by the MPPRCA's directive that the Secretary seek an international agreement to require equivalent measures to be adopted by foreign vessels.[26]

The MPPRCA's reception facility requirements also build upon the provisions of Annex V. The MPPRCA implements the Annex V reception facility directive by requiring regulations "setting criteria for determining the adequacy of reception facilities for garbage at a port or terminal, and stating such additional measures and requirements as are appropriate to ensure such adequacy."[27] The duty to provide adequate reception facilities is imposed on "[p]ersons in charge of ports and terminals...."[28] Failure to provide adequate facilities carries significant consequences—ships may be denied entry to any port or terminal that does not comply with the MPPRCA's regulatory standards.[29]

The MPPRCA provides little guidance on how the adequate reception facility requirement is to be met. Instead, the responsibility for developing a regulatory program to satisfy this requirement has been vested in the U.S. Coast Guard. At the time this article went to press, proposed regulations had been published.[30] Final regulations are expected to be published early in 1989.

The proposed regulations provide that the following classes of ports/terminals must satisfy MPPRCA requirements: (1) a group of terminals that combines to act as a unit; (2) an authority or organization that chooses to be considered a port; (3)

a facility that has been specifically designated as a port by its operator; or (4) facilities that provide wharfage or other services to ships, including commercial fishing facilities, recreational boating facilities, and mineral and oil industry shorebases.[31]

If a facility falls within one of these categories, it must meet requirements for accessibility, capacity, and the ability to receive and process food wastes regulated by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service ("APHIS") (e.g., by incineration, sterilization, or other means of ensuring against the spread of disease or pests).[32]

To satisfy the accessibility requirement, the terminal must ensure that facilities are "available" and capable of receiving all garbage that ships on call wish to discharge.[33] Exceptions apply for large quantities of spoiled or damaged cargos not usually discharged and garbage from ships not having commercial transactions with that port or terminal.[34] In addition, the reception facility must not impede cargo handling or terminal operations and must prevent discharged garbage from readily entering the water.[35]

To determine waste handling capacity, the Coast Guard has provided a worksheet to estimate the amount of refuse that can be expected to be discharged from ships.[36] Use of the worksheet would not be mandatory.

The proposed regulations specify that ports are to be capable of receiving APHIS regulated garbage no later than 24 hours after being given notice by a ship.[37] This requirement may be the most difficult for many ports to satisfy because special facilities are required. Purchasing the appropriate equipment, contracting with private waste haulers, or establishing cooperative waste management programs with other ports are possible options.

To implement this program, the proposed regulations indicate that a port must obtain a certificate of adequacy ("COA") if it receives oceangoing vessels subject to MARPOL requirements for oil and noxious liquid substances or receives more than 25 port arrivals annually by ships whose last port of call was outside the continental United States.[38] Even if a COA is not required, the port must meet MPPRCA requirements.

CONCLUSION

For decades, the world's oceans and waterways have served as a receptacle for substantial quantities of garbage, including plastics and other forms of persistent refuse. In recent years, the harmful effects of this practice have become apparent. In response, stringent domestic and international control authorities have been enacted, and ports have a central role in the regulatory regime. As a result of the visibility of the problem and the strong interest demonstrated by Congress, federal agencies, environmental groups, and the public, compliance with these new programs is certain to be closely watched. Port managers therefore will have to become familiar with these new requirements and implement efficient and innovative waste management systems that satisfy them. Although ports are not a significant cause of the marine debris problem, they undoubtedly will play a major role in administering the cure.

*Donald Baur formerly served as General Counsel of the U.S. Marine Mammal Commission. The authors appreciate the assistance of Pat Ware, legal assistant, Perkins Coie.

Notes

[1]Nat'l Acad. of Sci., "Marine Litter" in *Assessing Potential Ocean Pollutants* 405, 422 (1975).

[2]*Plastic Pollution in the Marine Env't, Hearing Before the Subcomm. on Coast Guard and Navigation of the House Comm. on Merchant Marine and Fisheries*, 99th Cong., 2d Sess. 87 (1986).

[3]For general information *see Proc. of the Workshop on the Fate and Impact of Marine Debris* (R. Shomura & J. Yoshida, ed. 1985).

[4]Hearings Before the Subcomm. on the Coast Guard and Navigation of the House Comm. on Merchant Marine and Fisheries, 99th Cong., 1st Sess. (1986) (statement of David Laist).

[5]*See* Day, Wehle, & Coleman, *Ingestion of Plastic Pollutants by Marine Birds, in Workshop Proc., supra* n. 3, at 344-386.

[6]International Convention of the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, 26 U.S.T. 2403, T.I.A.S. No. 8165.

[7]International Convention for the Prevention of Pollution for Ships, *done* Nov. 2, 1973, *reprinted in* 12 I.L.M. 1319 (1973), *as modified by*, Protocol of 1978, *opened for signature* June 1, 1978, *reprinted in* 17 I.L.M. 546 (1978).

[8]LDC, *supra* n. 6, art. III 1(a).

[9]MARPOL, *supra* n. 7, preamble.

[10]*Id.*, Annex V, reg. 3(1)(a).

[11]*Id.* reg. 3(1)(b).

[12]*Id.* reg. 3(2).

[13]*Id.* reg. 7(i).

[14]IMO, Marine Environment Protection Committee, *Guidelines for the Implementation of Annex V, Regulations for the Prevention of Pollution by Garbage from Ships* (Sept. 1988).

[15]*Id.* at §§6.1, 6.3.2.

[16]*See* IMO, Marine Environment Protection Committee, *Draft Guidelines for the Implementation of Annex V* at §§6.3.5, 6.3.6.

[17]*Guidelines, supra* n. 14, at 6.3.2.

[18]33 U.S.C. §407.

[19]33 U.S.C. §§1401-1445.

[20]33 U.S.C. §§1251-1376.

[21]Pub. L. No. 100-220, tit. II, 101 Stat. 1458 (1987) (codified at 33 U.S.C. §§1901-1912, 42 U.S.C. §6981, 33 U.S.C. §2267).

[22]33 U.S.C. §1902(a)(1).

[23]*Id.* §1902(a)(2), (3).

[24]*Id.* §1902(b)(1)(A), (2)(A).

[25]*Id.* §1903(b)(2)(A).

[26]*Id.* §1903(b)(2)(B).

[27]*Id.* §1905(a)(2).

[28]*Id.*

[29]*Id.* §1905(e)(2).

[30]53 Fed. Reg. 43,622 (Oct. 27, 1988).

[31]*Id.* at 43,641 (to be codified at 33 C.F.R. §151.05).

[32]*See* 7 C.F.R. pt. 330.

[33]53 Fed Reg. 43,646 (to be codified at 33 C.F.R. §158.420).

[34]*Id.* at 43,636 (to be codified at 33 C.F.R. §158.420(a), (b)).

[35]*Id.* at 43,646 (to be codified at 33 C.F.R. §158.410(a)(2)).

[36] *Id.* at 43,634-43,636.
[37] *Id.* at 43,646 (to be codified at 33 C.F.R. §158.410(a)(1)).
[38] *Id.* at 43,645 (to be codified at §158.135(a)-(c)).

MEETING ANNEX V REGULATIONS: REPORT ON A PORT-BASED PILOT PROJECT

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Plastic materials which are discarded or lost at sea, do not degrade and are causing serious problems. Animals become entangled in the debris or may eat plastic items, mistaking them for their food. Mariners are threatened when debris disables propellers and engines. Beach litter is a threat to tourism and in some cases public health. Public awareness of these problems has prompted regulations that effect mariners and ports.

Effective December 1988, the Marine Plastic Pollution Research and Control Act of 1987 which implements the provisions of the international treaty called Annex V of MARPOL, prohibits mariners from disposing of plastic material at sea and regulates the disposal of other refuse materials depending on distance from shore. Ports and all other revenue generating docking facilities are required, as of that date, to provide disposal facilities for this refuse.

The Marine Entanglement Research Program of the National Marine Fisheries Service funded a pilot program designed to anticipate what these new regulations might mean logistically and financially for ports. It also explored ways to increase mariner and community awareness of the marine debris problem in order to encourage refuse return to port and cooperation with port efforts. The pilot program was called the Marine Refuse Disposal Project and was conducted at the Port of Newport, a small but diversified port on Oregon's central coast. The Port received $97,000 of grant funds for the project and provided $28,000 of in kind support. The funds were used to investigate refuse reception facilitiy needs at the international shipping terminal, and to improve refuse services at the fishing vessel moorages (which serve 600 commercial vessels), and at the 600 berth recreational vessel marina. Grant funds were also used to produce and distribute a wide variety of educational materials such as posters, decals, brochures, and photographic displays.

Pilot project experiences reveal that meeting Annex V regulations can actually benefit a port. Ports will, in most cases, be able to meet their legal requirements to provide "adequate refuse reception facilities" easily and inexpensively. Additionally if port user group members and the community are encouraged to become involved in marine debris efforts, the port will receive assistance in logistical planning, facility improvement, and educational outreach efforts, and develop better working relationships with these groups and individuals. Furthermore, port and mariner involvement in these activities provides a tangible and positive focus for media attention. Ports and their users are seen as leaders in efforts to tend this serious ocean pollution problem.

The Newport Experience

Despite large increases in the amount of refuse being returned at the Port of Newport (due to a strong educational campaign), solid waste disposal costs were easily covered by the daily moorage charge or launch ramp fee, and will not require a user fee increase. To recover the solid waste disposal costs at the marina, $0.29/vessel/day is required, while at the commercial vessel docks, where a recycling program reduced refuse volumes, solid waste disposal costs run $0.13/vessel/day. The Port of Newport was actually able to *save* money as a result of the marine debris program efforts by eliminating existing refuse system inefficiencies. Though the port is receiving an estimated 30% to 50% more refuse from the commercial fishermen, refuse disposal costs were actually *decreased* by 5%. This was accomplished by instigating recycling and other efficiency measures, such as making sure refuse containers were full before they were hauled by the garbage company. Though increase in the port's refuse reception capacity was needed, such increases were accomplished at very low cost. By using readily available containers to receive recyclables, utilizing an unused barge, and organizing and designating unused space as a refuse reception area, the port was able to meet its additional capacity needs for about $2100.

By pursuing their input and involvement, Newport's commercial fishermen became the prime supporters of the port's logistical changes and educational efforts, and were effective motivators of their peers. Five fishermen served on the project's advisory group with other community members representing enforcement, refuse, wildlife, extension, business, boating and safety, and school groups. This group helped to plan the refuse system changes and encouraged the cooperation and involvement of other mariners. They also distributed posters and brochures, gave talks, handed out litter bags to vessels, and participated in various promotional activities to increase community awareness.

The media at first reported the problems caused by plastic—the entanglement of animals, the fouled propellers and engine intakes, the litter on area beaches, but soon was able to report the tangible efforts of the port. Reports mentioned the increased numbers of dumpsters, the recycling facilities, the innovative uses for discarded net. Community pride and support developed when the media highlighted the fishermen returning to port with 30 sacks of trash, recovering refuse left behind by others, experimenting with trash compactors, or holding contests at sea to see who could bring back the most trash.

Despite differences from port to port, many of the ideas and steps taken at the Port of Newport may be adaptable elsewhere. The remainder of the paper provides a brief overview of these ideas. Further information about the pilot program and suggestions for ports are contained in two publications available from the NOAA Marine Debris Information Office, 312 Sutter Street, Suite 316, San Francisco, CA. 94108, 415-391-6204. Ask for "A Report on a Port)Based Project to Reduce Marine Debris" or "Dealing with Annex V- A Reference Guide for Ports".

Defining Facility Needs

It is recommended that ports reassign or hire an employee temporarily to make sure that Annex V requirements are met quickly and beneficially. The following steps will define the type and capacity of refuse facilities needed:

1. Evaluate the existing port refuse reception facilities. Consider convenience to port users and define problem times, problem areas, or refuse materials.
2. Assess existing resources. Identify the on-hand or easily acquired materials that could be adapted for refuse services, e.g. 50 gallon barrels, barges, fork lifts,

bins, and containers.
3. Define capcity needs (see below) by observing what's being put in the refuse containers presently and what is not. Consider how much material is recyclable. Also talk with the port users. They can indicate how much refuse and what kind of refuse they need help getting rid of, and provide ideas on improving the convenience of refuse disposal. (Getting out on the docks and talking with port users can't be overemphasized. This will not only make sure ports are tailoring faclilities to users needs, but will be essential in gaining cooperation and support with recycling efforts).
4. Investigate the refuse and recycling services available in the area. Most ports will contract out their refuse hauling and disposal operations. Refuse handling can be a very competitive. Ports may be able to find or negotiate better service options and lower costs.

Defining Capacity Needs

How much refuse reception capacity will a port need and how can additional capacity be created if there's not enough?

1. Figure that, at minimum, the port will need 4-6 gallons of refuse reception capacity per person per vessel per day. This is the refuse that can go into garbage bags— the galley waste, the household waste, the bait trays, the scraps of net and line, pieces of hard hats, small repair items etc.
2. Additional capacity will be needed to handle the refuse that is generated when vessels are provisioned, e.g. packaging materials and cardboard boxes.
3. Additional capacity is also needed for any large repair or industry related items, e.g. cable, engine parts, wood, old nets, pallets, drums, crates, sheeting etc.

Again, talking with port users will provide a realistic idea of the quantities and types of materials that can be expected from the vessels.

Creating More Capacity

If more capacity is needed, it can easily, and often times inexpensively be created. Capacity can be increased by:

1. Adding additional or larger refuse reception containers (trash cans, dumpsters, barrels, totes etc.).
2. Increasing the frequency or refuse pick-up.
3. Clearing and reorganizing space at the port. This point should be emphasized: Capacity doesn't necessarily mean containers. Large amounts of refuse reception capacity can be created inexpensively, and very effectively. A pallet can be put down for cable, a space created to put nets, and a crate can be designated for wood or metal items. These facilities need to be readily accessible however (e.g. close to a hoist) and clearly marked, and mariners need to be informed of this area.
4. Diverting materials from the containers that don't need to be disposed of at the landfill. Recycling materials will leave more space in the dumpsters or trash cans for plastics and other refuse and reduce costs. Cardboard, metal, wood, and nets are easily recycled and can even generate revenue. Cardboard brings

from \$40-\$60 a ton presently, scrap iron and metal brings from \$25-\$50 a ton. Plastic materials too are being collected by some recyclers now, with large quantities being paid for by the pound. In Newport, untreated wood is being donated for the heating needs of senior and handicapped citizens in the community. Nets and net pieces are reused within the fishing industry and taken by residents and tourists for everything from baseball and golf backstops to garden supports, kids playgrounds, and decorations.

Recycling containers or areas need to be clearly marked and located adjacent to the refuse containers or in other convenient areas areas such as on water level barges, or adjacent to hoists. (Fish and ice storage bins make inexpensive recycling containers and only need to be painted and signed.)

In order for recycling to work, it is essential to enlist the cooperation of the mariners in separating the materials properly. By involving mariners throughout the planning and implementation stage, the recycling system is one which is "owned" by the mariners and not one imposed from the outside.

With some attention, a little organization, and a sincere commitment to meeting mariner needs, it is not difficult for ports to benefit from Annex V regulations as the Port of Newport did. A marine debris program can result in improved service to port users, increased refuse system efficiency, and lowered refuse disposal costs. It can also be an effective public relations tool. Mariner support and community pride can be fostered through involvement and the port can receive wide-spread acclaim for effectively dealing with a serious problem.

THE IMPACT OF ENVIRONMENTAL LEGISLATION ON PORT OPERATIONS: PERCEPTIONS AND ATTITUDES OF PORT MANAGERS IN THE SOUTHERN UNITED STATES

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Prior to the environmental movement begun in the 1960s, port operations, although regulated, were not as complicated by government regulations as they are today. In the past, port operators and managers had greater flexibility in port development and operations. The environmental movement, however, spawned a large number of regulations which have either directly or indirectly affected many different aspects of port operations and development (Boschken, 1982; Kester, 1983; Kusler, 1980). This study, is part of a larger study conducted by the Coastal Zone Management Studies program at the University of West Florida (Hester and Soden, 1988) which looked at federal environmental law, governmental agencies, political and non-political actors as they relate to port management within five southern states.

Ports and the Political Process

The overriding purpose of the environmental legislation which has blossomed over the course of the last three decades is to encourage and at times mandate state, regional and local government regulation (e.g., Coastal Zone Management Act, Clean Water Act, etc.) or actions parallel to federal activities. The implications of this for port operations are, at least, twofold. First, there are an increased number of environmental regulations by which ports increasingly must abide. Secondly, as a consequence of abiding by the law, there are a greater number of actors, both governmental and nongovernmental, who are involved in implementation of these regulations. The result is a greatly expanded political arena within which ports operate; expanding in both the complexity and the number of jurisdictions, and thereby increasing the number of policy actors. In addition to this are the vast number of businesses and environmental interest groups concerned with port development. Alone or in combination, these actors and various components of federal and state legislation comprise a complex political environment in which ports must operate to survive.

Ports have always been surrounded by interest groups, such as the business interests which made them thrive, and governments which have overseen operations from the days of the first custom agents. With the advent of increased environmental awareness, however, new issues and related regulations have spawned greater numbers of interests. Government agencies, relatively peripheral actors prior to World War II in many places, are now key participants in port development decisions whom no longer rule by benign neglect (Boschken, 1982). On the basis of this, environmental regulation and the burden it has placed on ports in terms of economic costs and future development are appropriate and timely topics for consideration.

The Study

The results reported here are based on a mail survey questionnaire designed from the pertinent literature regarding port operation and the impacts of environmental legislation and political activity in this policy issue-area (See, Hester and Soden, 1988; Reighard et al., 1988). The data collected for this portion of the study were obtained via a mail questionnaire survey distributed to 29 port managers in the States of Texas, Louisiana, Alabama, Mississippi and Florida. The survey included two mailings: an initial survey mailing and a follow-up survey mailing approximately one month later. The questionnaire was quite lengthy and required careful thought, as well as knowledge of the issue area. Of the 29 surveys mailed, 25 responses were obtained resulting in a response rate of 86 percent; a very respectable return which should allow generalization of the results at least across the geographic region of the Southern U.S. (A copy of the survey instrument is available upon request).

Findings

Table 1 reports the findings of port operators regarding the general value they see in environmental legislation. The largest response (44%), shows port managers feel that while some environmental legislation is in fact needed, there may be too much legislation overall. Respondents are split about whether too much or too little legislation exists. While there is a generally normal distribution about the issue, two further concerns draw our attention based on economic effects of environmental legislation. First, what financial burdens do port managers feel they have had to contend with because of environmental legislation? Second, how has environmental legislation impacted upon the growth of ports?

Tables 2 and 3 provide evidence based on five-item scales regarding the impact which environmental legislation is seen as having in terms of additional costs which port managers feel will be incurred. In Table 2 over one-half (52.0%) fall into categories four and five, indicating agreement with the idea that mitigation efforts result in "unwarranted expense." Over one- quarter, however, are in disagreement about the cost of mitigation and compensation. Table 3 records similar attitudes through consideration of the cost of impact of environmental regulation brought about by each level of government—federal, state and local. The data shows that the federal government is viewed as adding the most costs to port development projects, while local jurisdictions are viewed as being the least burdensome.

Beyond direct expenses, the effect of environmental legislation and regulation in port growth and development also requires investigation. Table 4 and 5 consider how environmental legislation is perceived as having an effect on port growth and how it has been a factor in contending with technological changes related to port operations. Table 4 illustrates that local jurisdictions are again seen as having the least impact in the environmental regulatory arena related to ports. This can no doubt be related to the fact that local jurisdictions typically seek economic development, and thus are less likely to take a position which hinders growth than are state or federal jurisdictions form which the bulk of regulation originates. With respect to new port technologies, Table 5 show general neutrality among port operators (44%) about the effect of adjusting to both technological breakthroughs in port operations and environmental issues at the same time.

Table 1
Port Operator's Views on the Value of Environmental Legislation and Policy

Question: In general, how would you characterize your view of environmental legislation and policies which affect port operations and growth?

Response Categories	Percentage
1. Although a hindrance, environmental legislation is necessary if we are to maintain the natural character of our coastal areas.	28.0
2. Some environmental legislation is needed, but overall we may be faced with too much legislation.	44.0
3. There is a great deal of environmental legislation which is unnecessary and thus places too great of a burden on port operators.	24.0
No Answer	4.0
Total	100 %

Conclusions

The pattern emerging from the data is quite pronounced. Among port operators the general attitude exists that environmental legislation has added additional costs to port operations but no overwhelming evidence prevails to suggest that port operators feel inclined to dispose of environmental programs. An important message concerning port operations emerges from this study in two respects. First, concerns about environmental quality and regulating are present in society and port operators do not discount them as entirely necessary, despite the burden they may place on operators, growth, and development. Second, if ports are to continue to operate and be economically viable, an increasingly difficult thing to do given today's competitive port economics, they must comply with environmental regulations and seek effective methods to resolve environmental quality issues. This would tend to parallel a considerable amount of social science literature which focuses on change from an industrial to a post-industrial society (Inglehart, 1977). This includes the growth of a new view of the environment as a result of post-industrial values (Milbrath, 1984; Dunlap and Van Liere, 1978), and lastly which shows that among the general public, activists and professional managers there exists an acceptance of concern for the environment and environmental regulation (Soden et al., 1989; Steel and Soden, 1989). The findings presented here are preliminary in many respects. While there are differences in the attitudes about the impact which environmental legislation and regulation has on port operators, the generalizations are limited by the regional scope of the study. Moreover, recent trends in the direction of greater efforts at contending with environmental legislation via such concepts as Environmental Management Units, may well give rise to less conflict and more cohesion and coordination between ports, various jurisdictions having standing and environmental regulation. Additional value is garnered from this study by providing an "insiders" view, that of the port operators, regarding the impact which the they feel environmental regulation has had on port economies. Further, the evidence is suggestive enough to lead a national port study so that comparison can be made across region (i.e., West Coast versus Great Lakes, the Southern U.S. Versus New England). The institutionalization of environmental concerns vis-a-vis regulation and broad societal trends makes it important that we enhance our understanding of this important coastal environment to insure that a balanced view from insiders as well as active outsiders is obtained, allowing us to benefit from the contribution they can make to the decisions we make regarding our valued port assets.

TABLE 2
Port Operator's Perceptions of the Costs Associated With Mitigation and Compensation Measures

Question: Over the last several years, environmental management agencies have required mitigation and compensation measures whenever fish and wildlife habitats are impacted because of dredging and filling. Port interests have often argued against mitigation and compensation costs, citing them as prohibitively expensive and arguing that these costs can reverse the financial feasibility of a project. In your view, does mitigation result in an unwarranted expense?

Response by Percentage

Strongly Disagree 1	2	Neutral 3	4	Strongly Agree 5
4.0	24.0	12.0	32.0	20.0

TABLE 3
Added Port Development Costs Due to Federal, State and Local Environmental Regulations

Question: In the last 10-15 years, to what degree do you feel additional costs have been added to port development projects due to environmental regulation at each level of government?

Level of Government	**No Answer**	**1 A Little**	**2**	**3 Some**	**4**	**5 A Great Deal**
Federal	8.0	8.0	12.0	20.0	28.0	24.0
State	8.0	8.0	8.0	8.0	24.0	20.0
Local	8.0	12.0	32.0	32.0	12.0	8.0

TABLE 4
Effects of Environmental Regulation on Port Growth and Development

Question: To what degree do you feel environmental regulation at each level of government has hindered the growth and development of your port?

Level of Government	No Answer	Response by Percentage 1 A Little	2	3 A Great Some	4	5 Deal
Federal	8.0	24.0	8.0	20.0	24.0	16.0
State	8.0	24.0	8.0	24.0	24.0	16.0
Local	8.0	28.0	24.0	28.0	4.0	8.0

TABLE 5
Accommodating New Port Technologies In the Face Of Emerging Environmental Quality Issues

Question: To what degree, if any, do you feel the present economic situation of your port is characterized by this statement: "Just as the port arrived at the development phase to accommodate new technology, environmental quality issues emerged making it difficult, if not impossible, for the port to adjust and remain competitive."

Response by Percentage				
Strongly Disagree		Neutral		Strongly Agree
1	2	3	4	5
8.0	16.0	44.0	24.0	4.0

REFERENCES

Boschken, H.L. (1982) "The Demands of Conflicting Change on Public Enterprise: West Coast Seaport Development and Environmental Regulation." PUBLIC ADMINISTRATION REVIEW. 42,3 (May/June):220-226.

Dunlap, Riley E. and Kent Van Liere (1978) "The New Environmental Paradigm," in THE JOURNAL OF ENVIRONMENTAL EDUCATION. 9,4:10-19.

Inglehart, Ronald (1977) THE SILENT REVOLUTION. Princeton, New Jersey: Princeton University Press.

Hester, Worth and Dennis L. Soden (1988) "The Impact of Environmental Issues and Legislation on Port Operations: Findings From Port Managers in the Southern United States." OCCASIONAL PAPER IN COASTAL STUDIES. No. 88-3, Pensacola, FL: The University of West Florida.

Kester, D.R., B.H. Ketchum, I.W. Duedall, and P.K. Park (1983) WASTES IN THE OCEAN: DREDGED-MATERIAL DISPOSAL IN THE OCEAN. New York: John Wiley & Sons, Inc.

Kusler, J.A. (1980) REGULATING SENSITIVE LANDS. Cambridge, MA: Ballinger Publishing Co.

Milbrath, Lester W. (1984) ENVIRONMENTALISTS: VANGUARD FOR A NEW SOCIETY. Albany, NY: State University of New York Press.

Reighard, James, Dennis L. Soden, and Worth H. Hester (1988) "Outside Influence on Port Operations: The Insider's Perspectives." OCEANS '88. Washington, DC: Marine Technology Society.

Steele, Brent S., Dennis L. Soden (1989) "Sources of Support for Forceful Government Action to Reduce Impact of Political and Environmental Value Orientations Among Citizens, Environmentalists and Legislators," in SOCIAL SCIENCE JOURNAL. (forthcoming).

Soden, Dennis L., Nicholas P. Lovrich, John C. Pierce, and Berton L. Lamb (1989) "Public Involvement in Natural Resource Policy Processes: A View from the Inside-Out," in THE ENVIRONMENTAL PROFESSIONAL. (forthcoming).

COLUMBIA RIVER ESTUARY DREDGED MATERIAL MANAGEMENT PLAN: A COOPERATIVE LOCAL, STATE, AND FEDERAL APPROACH

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Development of the Dredged Material Management Plan was funded by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C., through a grant made under Section 309 of the Coastal Zone Management Act of 1972, as amended, to the National Coastal Resource Research and Development Institute, Newport, Oregon.

Introduction

The Columbia River Estuary is located in the northwestern United States on the border between the states of Oregon and Washington. The estuary encompasses the lower 50 miles of the Columbia River. A small deep-draft port and several boat basins are located in the estuary. Larger Columbia River ports such as Portland, Oregon, and Vancouver, Washington, are located about 50 miles upriver from the estuary. The estuary contains major navigation facilities serving both the upriver and lower river ports.

More than 9,000,000 cubic yards of sediments are dredged annually from the estuary to maintain navigation facilities. More than 95% of this dredging is for federally maintained projects, including a 50-foot entrance channel to the estuary, 40-foot main navigation channel to Portland, Oregon, and several smaller channels serving boat basins. Projected construction of new water-dependent development projects in the estuary may involve several million cubic yards of additional dredging over the next ten years. Dredged material is currently placed at both upland and in-water sites. Over the past decade, many available upland disposal sites have been filled to capacity and environmental impacts due to in-water disposal have generated increasing concerns with regulatory agencies.

Coastal Zone Management Plans on the Columbia River Estuary are developed by the Columbia River Estuary Study Taskforce (CREST). CREST is a regional bistate governmental council composed of a membership of cities, counties and port districts on the estuary. In 1979, CREST developed a dredged material management plan as part of their regional management program (CREST 1979). By 1985, CREST identified the need to revise the Dredged Material Management Plan to address growing concerns about lack of adequate disposal sites and inefficient dredging regulation.

In 1986 and 1987 CREST developed the "Columbia River Estuary Dredged Material Management Plan" (Fox 1986) and a companion document, "Dredging and Dredged Material Disposal Policy Evaluation" (Fox 1987). The Plan inventories upland and in-water disposal sites and compares site capacity with anticipated disposal needs. Dredging and disposal policies and specific regulatory standards are also established in the Plan and companion document. The policies and standards are tailored to meet specific dredging and disposal requirements in the estuary while remaining consistent with Federal, and Oregon and Washington state policies.

The planning process involved a coordinated effort among local, state, and federal regulatory agencies, developers, and private citizens. Consensus agreements on disposal sites and regulatory policies were reached through a series of meetings. The Plan focused on reducing natural resource damage and estuary user group conflicts while allowing for necessary construction and maintenance of navigation facilities. The close working relationship developed among the participants in the planning process lead to the successful resolution of dredging issues.

Purpose and Content of the Plan

The purpose of the Dredged Material Management Plan is to refine the dredging and disposal policies originally developed by CREST in 1979 and to inventory an adequate number of disposal sites with sufficient capacity to accommodate projected disposal needs for at least a five year period. A five year span was selected as the minimum planning period. Many of the inventoried sites provide for disposal over a much longer time span.

In addition to providing for disposal needs and refining regulatory policies, the Plan is intended to serve as a guide to dredging project sponsors and regulatory agencies in planning and reviewing dredging projects. In order to be a useful guide, it focuses on disposal sites that are both in the proximity of the dredging areas and appear approvable under existing regulatory requirements. In this way, the plan could be used to expedite the dredging project sponsors' search for appropriate disposal sites and the regulatory agencies' permit review process.

The Plan is not intended to be an exhaustive list of all possible disposal sites and it in no way restricts disposal to designated sites only. Also, the Plan does not guarantee site availability. In many cases designated sites are privately owned and their use requires owner approval. The Plan does not obviate the need to obtain dredging and disposal permits. In all cases, use of a site for dredged material disposal has to conform with local, state, and federal regulatory requirements.

The Plan consists of six major sections. The first provides updated policies and standards for regulating dredging and disposal projects. These are further refined in the companion document to the Plan. The second and third sections include information on disposal site designation and plan implementation. The fourth section presents a summary of existing and potential dredging projects in the estuary and a projection of dredging volumes for a five year period. The fifth section inventories disposal sites needed to meet the projected dredging requirements. The final section compares the site and project inventories to determine if designated sites are adequate to meet dredging needs.

Planning Process

CREST coordinated development of the Dredged Material Management Plan with government organizations, citizens, and development interests in the lower Columbia River. To accomplish this coordination, CREST established two groups to assist in plan revisions. The first was a general review group consisting of about 65 individuals representing local governments, state and federal agencies, ports, citizens, commercial fishing interests, diking districts, and development interests.

This group reviewed an initial draft disposal site inventory and the draft Dredged Material Management Plan. The second group, the Dredged Material Disposal Advisory Committee, consisted of 22 representatives from the general review group. This committee participated directly in developing the Plan through a series of workshops.

The process of developing the Dredged Material Management Plan to meet anticipated dredging needs began with the production and distribution of an initial draft disposal site inventory. The inventory listed sites from the earlier CREST planning documents (CREST 1979), a 1983 Corps Maintenance Disposal Plan for the Columbia River (US Army Corps of Engineers 1983), and local comprehensive plans and shoreline master programs. The advisory groups reviewed and provided comments on the site inventory. Then, CREST conducted Advisory Committee workshops to refine the inventory by adding new sites in areas where additional disposal capacity was necessary, deleting sites that were found to be unavailable due, for example, to the presence of large areas of significant wetlands, and redefining the boundaries of many sites to avoid potential environmental and land-use impacts. The Advisory Committee also worked to revise the dredging and disposal regulatory policies at the workshops. Both the updated inventory and revised policies were incorporated into the Plan.

The planning process also addressed several outstanding dredging and disposal issues in the estuary. Some of the issues of primary concern are listed below.

Flowlane Disposal
- priority of selecting flowlane disposal versus upland and ocean disposal alternatives
- designation of a flowlane disposal area
- disposal monitoring

Sediment Testing Requirements
- under which testing is required
- criteria based on test results

Beach Nourishment
- extent to which in-water disposal regulations apply to beach nourishment
- circumstances under which beach nourishment could be allowed on beaches that do not have an erosion problem

Conflicts between Commercial Fisheries and Dredging Projects
- gear conflicts
- disturbance of fishing grounds

Consensus agreements dealing with each issue were reached at the meetings and are summarized in the companion document to the Plan (Fox 1987).

Plan Adoption and Further Work

The Dredged Material Management Plan was written in a format suitable for incorporation into local government comprehensive planning documents and will become part of Oregon's and Washington's Coastal Zone Management Programs.

It is now in the process of being adopted and is scheduled to be in all jurisdictions' programs by the end of 1989. Once incorporated, the plan will allow for more effective regulation of dredging projects through the local permit and federal consistency review processes. The Corps of Engineers has responded to the need for a consistent planning effort on the estuary by incorporating much of the CREST work into their own dredging planning documents for the lower Columbia River (US Army Corps of Engineers 1987; US Army Corps of Engineers 1988).

CREST and the Portland District Army Corps of Engineers are currently conducting additional dredged material management planning projects in the estuary. CREST recently received a grant to develop a program for reviewing in-water disposal projects with respect to contaminated sediment concerns. The project will attempt to coordinate Oregon's and Washington's sediment testing regulations in the bistate waters of the Columbia River Estuary. The Portland District Army Corps of Engineers has begun developing a 50 year maintenance plan for a portion of the main navigation channel in the estuary. This plan is being developed under their Long Term Management Strategy (LTMS) authority.

Literature Cited

CREST. 1979. Columbia River Estuary regional management plan. Astoria, OR: CREST.

Fox, D.S. 1986. Columbia River Estuary dredged material management plan. Astoria, OR: CREST.

Fox, D.S. 1987. Dredging and dredged material disposal policy evaluation. Astoria, OR: CREST.

US Army Corps of Engineers. 1983. Columbia River, downstream of Bonneville Dam, maintenance disposal plan. Portland, OR: US Army Corps of Engineers.

US Army Corps of Engineers. 1987. Columbia River, downstream of Bonneville Dam, maintenance disposal plan. Portland, OR: US Army Corps of Engineers.

US Army Corps of Engineers. 1988. Long-term management strategy for 40-foot channel maintenance dredging in the Columbia River Estuary. Draft Phase I Report. Portland, OR: US Army Corps of Engineers.

DREDGED MATERIAL DISPOSAL MANAGEMENT MEETING THE CHALLENGE FOR BOSTON HARBOR

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ABSTRACT

Managing disposal of dredged materials from urban harbors is complex because of: 1) uncertainties about what constitutes "contaminated" sediments, 2) limited availability of disposal sites 3) jurisdictional and regulatory responsibilities, and 4) the high cost of implementing solution. These issues are to be addressed in the development of a dredged material disposal management plan for Boston Harbor, a Generic Environmental Impact Report (GEIR) which is the initial phase of an implementation of a management program. This GEIR is timely because of the proposed major projects that will require dredging of sediments, including some of the "hot spots" within the harbor.

Because no formal sediments that fail to satisfy the ocean dumping criteria, will integrate sediment contaminant concentrations, known sources of pollutant input and biological data with sediment contaminant levels that will be dredged over the next 20 to 50 years.

This paper discusses the adequacy of the results of current protocols for determining suitability of sediments for open ocean orders of magnitude as is the case for tissue residue concentrations. There is not apparent recommendations of this paper are to focus on the improving the validity of the data collected as currently required by the federal agencies and to recommend new approaches.

INTRODUCTION

Sediments are the repository for particulates and associated contaminants that enter estuaries and near shore environments from point and non-point sources of discharge. The management of dredged material disposal requires guidelines on sediment quality and on having the options and sites for safe disposal. Because of the lack of understanding of the relationship between sediment contaminants and their effects on the ecosystem and human health, neither chemical criteria nor adequate biological tests have been developed that clearly and unambiguously define what constitutes "clean" and/or "contaminated" sediments (White and Champ, 1982). Without clear regulations, making decisions regarding appropriate disposal of dredged material from urban harbors is both challenging and difficult in the face of uncertainty about real or perceived benefits and high costs associated with disposal option.

This paper examines our current status of sediment contamination in Boston Harbor based on results from studies reported with dredging projects. What emerges from this analysis is the awareness that our current testing requirements are inadequate in providing valid data to decision makers. As state and federal agencies seek to balance environmentally sound disposal of contaminated dredged material with cost effective options, these sediment criteria definitions become important factors to resolve.

BACKGROUND

Our current system for evaluating sediments is based on the protocols set forth by the Environmental Protection Agency (EPA) and the Army Corps of Engineers (COE) (EPA-COE, 1977). Sediments are analyzed for grain size and, if warranted, for contaminants. If contaminants exceed certain levels, additional biological testing is required. Two biological tests used extensively for determining whether toxics are present in toxic amounts and likely to degrade the environment are the bioassay and bioaccumulation tests. Bioassay tests measure mortality of laboratory animals exposed to sediments, and all tests must be repeated if mortality is greater than specified levels.

Bioaccumulation tests expose organisms to sediments from the dredged site and from reference sediments near the disposal site. A third group of sediments are the control sediments which are determined to be "clean." If tissue residues of chemicals are higher in test animals than those in animals exposed to the reference sediments, then it is presumed that degradation of the environment will occur and the sediments should not be disposed of in unconfined open water sites. In Massachusetts, three organisms are used in these tests, the polychaete, *Nereis virens*, the hard shell clam or quahog, *Mercenaria mercenaria* and the mud shrimp, *Palaemonetes pugio*. Five chemicals are tested, cadmium (Cd), mercury (Hg), ploychlorinated biphenyls (PCBs), DDT deratives and petroleum hydrocarbons (PHCs) with polynulcear aromatic hydrocarbons (PAHs) being also required as of a year ago. To date, only 4 projects that are to be funded by the Commonwealth have failed the bioaccumulation tests, despite positive results in significant uptake of chemicals. The reason is that there are virtually no alternatives to the Foul Area Disposal Site (FADS), a deep water site located 22 nautical miles from Boston, even though disposal at this site is costly.

Historically, there were a number of underwater disposal sites located along the Massachusetts coast. About a decade ago, disposal at these sites was discontinued leaving four options; upland disposal, nearshore disposal, beach nourishment and disposal at the Foul Area Disposal Site (FADS). Currently an Environmental Impact Statement is being prepared by the Environmental Protection Agency with the cooperation of the New England Division of the Army Corps of Engineers to determine if the FADS should be designated and to examine the feasibility of capping at that site. The other disposal options, upland and nearshore and beach nourishment, are not viable alternatives for several reasons:

1. land costs near major urban centers are high and other competing uses are more likely to use available open spaces (Sasaki, 1983),
2. recent changes in regulations prohibit disposal of sediments with high salt content in areas of ground water discharge for drinking supplies (exceptions to this include disposal areas that are permitted to accept dredged material),
3. sediments from urban harbors are usually silty and not suitable for beach nourishment, and
4. nearshore disposal usually destroys salt marshes or aquatic habitats which are regulated by the Massachusetts Wetlands Protection Act and Chapter 91 of federal regulations.

As a result of the lack of alternative dredged material disposal sites, most dredging projects from Boston Harbor are permitted to dispose of dredged material in the FADS irrespective of the level of contamination. For the past decade, it has been recognized that additional sites are needed for disposal of dredged material, especially for contaminated sediments. Boston Harbor sediments typically contain high level of PHCs, PCBs, several metals and a variety of other chemicals (See, for example, Boehm, *et al.* 1984, Shiaris, 1986, NOAA, 1987.) Because of the high correlation between PAHs and fish pathologies, there is concern for disposing of sediments from Boston Harbor into Massachusetts Bay.

Currently the EPA and COE with other federal agencies are revising protocols for testing dredged materials. It is expected that the new protocols will be more stringent than previous protocols and that Region I EPA will be adopting these protocols within the next 6 months (Tomey, pers. comm.). If sediments that were formerly acceptable for ocean disposal become classified as unsuitable, these protocols may have serious ramifications for Boston Harbor and other urban embayments.

Because of areas that are deemed unsuitable for open ocean disposal, the Massachusetts legislature allocated funding for a Generic Environmental Impact Report to evaluate disposal options and sites for the disposal of contaminated dredged material from Boston Harbor. For a variety of reasons, this study has not yet been initiated. As a result, the rest of this paper discusses the adequacy of our current testing procedures and makes several recommendations that will improve the validity of the results under the current testing requirements.

METHODS AND APPROACH

Data provided to the MEPA (Massachusetts Environmental Policy Act) Office were used to examine spatial distributions of contaminants throughout the harbor and to evaluate the biological testing results (MEPA, 1982-1986). Data sets were presumed to have adequate quality control, although the quality control/quality assurance information was not usually supplied. Moreover, field sampling procedures are not uniform and this further confounds the consistency of the results and limits interpretation of the data. Because of the inconsistencies of the data, it was deemed inappropriate to apply statistical methods to correlation analysis.

RESULTS AND DISCUSSION

Bioassay Tests

Bioassay tests measure mortality when organisms are exposed to control, reference and dredged or test material. Although no test has ever been rejected because a single group of organisms had higher than 10% mortality, in fact this occurred nearly 40% of the time for *Nereis* and *Palaemonetes* exposed to dredged material (Table 1). These results suggest the need for a more careful evaluation of this test.

Table 1. Bioassay results as reported in MEPA studies of dredging projects between 1982 and 1986. Data report number of tests with more than 10% mortality over the total number of studies reported.

ORGANISM	CONTROL	REFERENCE	DREDGED
Nereis	0/9	1/11	4/11

Mercenaria	0/9	0/11	0/11
Palaemonetes	0/9	1/11	4/11

Bioaccumulation Tests

A comparison of the accumulation of specific chemical concentrations in tissue residues of organisms exposed to dredged material compared to organisms exposed to reference sediments suggests differences between organisms in their response to specific chemicals (Table 2). In analyzing the data of both sediment and tissue residue concentrations of contaminants, it became apparent that the range of results from the analyses was often an order of magnitude or greater different between studies. Because PCB uptake occurred (significant or not) more frequently than with other chemicals, tissue residue concentrations were compared to sediment concentrations. There was no apparent increase in tissue residue concentrations that can be correlated with increasing sediment concentrations. With the possible exception of Cd, other comparisons of sediment and tissue levels show similar scatter.

Although the data summarized in this paper are weak, inconsistent and, in some cases, possibly erroneous, this is the type and quality of data on which decisions are made. These data do not meet minimal academic standards. Nonetheless, managers determine the level of sediment "contamination" based on the values given and determine whether sediments are suitable for unconfined ocean disposal. Furthermore, these biological tests are expensive ranging between $15,000, to $20,000 per test.

Table 2. Numbers of studies reflecting levels of accumulation in tissue residues of organisms exposed to dredged material compared to reference material. Three categories are given; N.S. indicates accumulation, but not significant; SIGN. refers to significant uptake at the .05 level and N.ACC. indicates there was no accumulation. Results are based on ten studies that had adequate data.

ORGANISM	RESPONSE	Cd	Hg	PCB	PHC*	DDT
Nereis	N.S.	3	5	3	6	0
	SIGN.	1	0	7	0	0
	N.ACC.	6	5	0	4	10
Mercenaria	N.S.	2	3	5	4	0
	SIGN.	0	2	2	1	0
	N.ACC.	8	5	3	5	10
Palaemonetes	N.S.	0	0	2	5	1
	SIGN.	0	4	5	1	0
	N.ACC.	10	6	3	4	9

*Within the past year, the COE has required PAHs to be analyzed, but they are not consistently reported, *i.e.* which PAHs are analyzed is not always reported. Methodologies are not standardized and detection levels are not always appropriate. Only one report included PAHs, thus in this table PHCs were reported.

Rather than overinterpret scanty and inconsistent data, the rest of this discussion focuses on several areas where methods and protocols can be improved under existing regulations. Other more creative, more consistent and more cost effective approaches should be incorporated into the decision matrix as currently applies. The high correlation between PAHs in sediments and the indicence and prevalence of diseases in fish and shellfish suggests that low levels of selected chemicals degrade the environment (EPA, 1988; NOAA, 1987). If conservative risk assessment methodologies are applied to determine cancer risk to humans using contaminant levels in fish and shellfish from Quincy Bay, then we have reason to be concerned about disposal of sediments from urban harbors despite the lack of supporting data from the biological testing (EPA, 1988). The effects of PCBs on vertebrate reproduction and implied immune deficiency responses coupled with the potential for these chemicals to be bioaccumulated, further underscores concern (Swain, 1988). Thus, decision makers need to integrate three concerns, (1) sediment levels that potentially will degrade the environment, (2) environmentally sound disposal sites that are viable option, and (3) options that are cost effective and suited to the level of contamination.

RECOMMENDATIONS

The following recommendations are by no means complete, but are intended as guidance for decisions makers. Ideally, for Boston Harbor, the Generic Environmental Impact Report (GEIR) will address these issues, but given the funding situation, some recommendations may be examined independently of the GEIR Other approaches to examining sediment criteria levels, e.g. the triad approach (Chapman, 1986) and the Apparent Effects Threshold (PSSDA, 1986) are expensive to implement given the lack of supporting data that currently exists. Filling in necessary data gaps will be expensive and not likely within the foreseeable future.

1. A top priority for Massachusetts is to insure valid data. This includes standardizing protocols for all field and laboratory sampling by all participating consultants, agencies and laboratories; implement compositing methods for dredged materials used in analyses; standardize reporting procedures and require periodic split sample analyses between and among participating laboratories.
2. Although retesting of composited dredged material used in biological testing is now required it is not implemented by the COE.
3. Analyses of organic carbon should be standardized and all sediment contaminant data normalized based on total organic carbon (See Boehm, et al. 1984).
4. A standardized PAH protocol should be established, as well as agreement on what chemicals constitute PAHs of concern.
5. A matrix for decision making should be developed by state and federal agencies that includes more than sediment analyses and the results of biological test.
6. Additional studies should include tissue residue analyses of indigenous species.
7. New biochemical techniques should be screened as potential substitutes for current biological testing.
8. The Generic Environmental Impact Report would be funded as the initial stage in developing a management plan which may apply to other urban harbors with similar difficulties.

In summary, our current testing protocols for determining whether sediments are suitable for ocean disposal are inadequate based on the data available to the MEPA office. Because it is costly to be too conservative in defining "contaminated" sediments and providing alternative disposal sites, our current practice is to dispose of all sediments in the deepwater site. However, it is equally costly to degrade the environment and/or increase the cancer risk to human. Several of the recommendations have a high potential to improve the quality of the data and may be implemented at a minimal cost. Given the high cost of the alternatives, addressing these issues should be a priority.

REFERENCES

Boehm, P.D., W.G. Steinhauer, and J. Brown. 1984. Final Report on organic pollutant biogeochemistry studies, Northeast U.S. marine environment. Part I: The state of organic pollutant (PCB, PAH, coprostanol) contamination of the Boston Harbor-Massachusetts Bay-Cape Cod Bay System: sediments and biota and Part II: Organic geochemical studies in the Hudson Canyon and Gulf of Maine areas. 61 pp. Report to the national Oceanic and Atmospheric Administration (NOAA), Ocean Assessments Division, Rockville, MD.

Chapman, PM 1986. Sediment quality criteria from the sediment quality triad—an example. *Environm. Toxicol. Chem.* 5: 957-964.

Environmental Protection Agency, 1988. analysis of Risks from Consumption of Quincy Bay Fish and Shellfish. 69 pp plus appendices.

Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material, "Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters; Implementation Manual for Section 103 Public Law 92-532 (Marine Protection, Research, and Sanctuaries Act of 1972)," July 1977 (Second Printing April 1978), Environmental Effects Laboratory, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Massachusetts Environmental Policy Act Studies, 1982-1986. Studies submitted to MEPA regarding dredging of sediments in Boston Harbor. 10 reports.

National Oceanic and Atmospheric Administration, 1987. National Status and Trends Program for Marine Environmental Quality Progress Report and Preliminary Assessment of Findings of the Benthic Surveillance Project—1984, Office of Oceanography and Marine Assessment, Rockville, MD, 81 pp.

Sasaki Associates, Inc. 1983. Upland Dredged Material Disposal Site Analysis prepared for the Massachusetts Coastal Zone Management Program of the Executive Office of Environmental Affairs.

Shiaris, M.P., D. Jambard-Sweet. 1986. Polycyclic aromatic hydrocarbons in surficial sediments of Boston Harbor, Massachusetts, *Marine Pollution Bulletin* 17: 469-472.

Swain, W.R. 1988. Human health consequences of fish contaminated with organochlorine compounds. *Aquatic Toxic.* 11: 357-377.

White, H.H. and Champ M.A. "The Great Bioassay Hoax, and Alternatives, "Hazardous and Industrial Solid Waste Testing: Second Symposium, ASTM STP 805, R.A. Conway and W.P. Gulledge, Eds. *American Society for Testing and Materials*, 1983. pp. 299- 312.

WISCONSIN'S DREDGE DISPOSAL DILEMMA—AN ATTEMPT TO BALANCE ECONOMIC AND ENVIRONMENTAL CONCERNS

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I am here today to represent the perspective of the water transportation industry in describing the dredge disposal dilemma facing our state of Wisconsin. Although Wisconsin has shoreline bordering both the Great Lakes and the Upper Mississippi River, I will focus only on dredging as it relates to our harbors on the Great Lakes—Lake Michigan to the east and Lake Superior to our north. My presentation will include three topics: first, a brief orientation to Wisconsin—our transportation system and background on our dredge disposal policy; second, an overview of the regulatory framework under which we are operating; and third, an analysis of recently proposed dredging regulations as viewed from a transportation perspective.

Orientation to Wisconsin

Wisconsin is located at the far western end of the St. Lawrence Seaway—a continuous waterway extending more than 2,300 miles from the Atlantic Ocean to the heart of North America.

There are fourteen major commercial harbors along Wisconsin's Great Lakes shores. They handle, on an average, more than 50 million tons of cargo annually at a value greater than 7 billion dollars. High value metallic ores, farm products, coal, and manufactured goods funnel through Wisconsin's ports from at least 7 states and two Canadian provinces. Much of the grain and manufactured goods are bound for countries all over the world.

The need to maintain our navigation channels and to dredge is perpetual. Sediment from streams feeding into the lakes, erosion of shoreland banks and beaches, and movement of materials within the lakes all contribute to the need to routinely dredge navigation channels for commercial shipping.

Wisconsin has long opposed the disposal of dredged material into the waters of the state initially with a concern for protecting navigation. Before 1970, Wisconsin had no jurisdiction over the disposal practices of the U. S. Army Corps of Engineers. Awareness of the environment grew and shifted concern to protection of the resource rather than to navigation alone. As a result, Wisconsin promulgated a series of policies which challenged Corps of Engineers' practices. Key points in this evolution include:

First, a gubernatorial prohibition against open-water disposal of polluted material in 1970;

Second, the classification of all dredged material as a pollutant whose disposal into the water required a permit in 1973; and

Third, in 1977, a prohibition against the disposal of all dredged material into the water whether it was polluted or not. This prohibition remains to this day. All dredged material is considered to be a pollutant whose discharge into state waters requires a permit from the State Department of Natural Resources.

Overview of Regulatory Framework

Dredge material disposal in Wisconsin is governed not only by state and federal regulations, but through an international agreement as well. The earliest basis for the federal regulation of dredging is the commerce clause of the U. S. Constitution which gives Congress the power to regulate interstate commerce. There is no single, comprehensive federal dredging regulation, law, or agency. Regulation of dredging and disposal of dredged materials has grown out of a wide spectrum of legislation and is administered by numerous federal governmental agencies. The primary federal actors are, however, the U.S. Army Corps of Engineers and the Environmental Protection Agency (EPA).

The 1899 Rivers and Harbors Act authorized the Department of the Army to require Corps approval and a permit for any construction or work in navigable waters. Prior to 1968, the Corps administered the Act for the purpose of protecting navigation. In 1968, the federal regulations were revised to require Corps review of other factors such as impact on fish, wildlife, aesthetics and the public interest.

In 1974, the Corps permit power over discharge of dredged material was superseded by permit certification of the EPA. The Corps permitting process is now used as a vehicle for implementing state and national policies on water quality and wildlife protection. As a matter of policy, permits will not be issued by the Corps when the state or local government do not concur that the work should be done.

In 1969, the Corps of Engineers recommended legislation for constructing diked disposal facilities to contain polluted material, and in response, Section 123 of The River and Harbor and Flood Control Act of 1970 was enacted. It authorized the Corps to construct confined disposal facilities for Great Lakes' projects, in concurrence with local governments and the EPA. This was a one-time program and the confined disposal facilities that were built under this program are filling up.

The Corps is in the process of changing the way they do business. In the past, they paid the entire cost of maintenance dredging and dredge disposal necessary to keep federal navigation channels in the Great Lakes at suitable depths for shipping—whether the material is considered clean or polluted. In the future, if the Corps determines that dredged material is clean enough to return to the water and the state requires it to go upland, the state or local sponsor will have to pay the added cost associated with upland or more restrictive disposal. The Corps will no longer pay disposal costs which exceed what is required by the "federal standard."

Dredged material management in the Great Lakes is also influenced by an international water quality agreement between the United States and Canada. The International Joint Commission oversees progress on that agreement and is presently in the process of evaluating dredged material disposal in the Great Lakes. It has identified significant "areas of concern" and is attempting to encourage the rehabilitation of highly contaminated harbors which have been receiving industrial wastes for more than a century. Wisconsin has four of these designated "areas of concern."

Proposed Changes in State Law

State law governing dredged material disposal is being re- evaluated in Wisconsin. The State Department of Natural Resources (WisDNR) is proposing changes to the Wisconsin Administrative Code pertaining to the regulation of dredging and dredged material disposal. These changes involve: 1. the establishment of criteria and procedures for determining whether dredged material is clean, and 2. the creation of a new rule to apply solid waste regulations to the confinement of dredged material.

Transportation interests have some major problems with the proposed rules:

1. Proposed state standards for judging whether dredged material is *clean* enough to go back into the water are stricter than federal standards. While the state has a policy of not wanting to degrade the environment any more than what already exists, they have established standards that are more restrictive than what appears to be found naturally in the bluffs lining the shores and depositional zones of the lakes. A question remains as to whether returning sediment containing low levels of compounds, such as dioxin and furan, to the lakes would degrade the lakes further or whether placing or confining it upland would serve a benefit to the environment—especially since placing the material upland rather than into the water costs, at a minimum, two to three times more.
2. The proposed rule will treat all dredged material, including clean Sediment, as solid waste. It also requires that all new confined disposal facilities be constructed under the same stringent guidelines as sanitary landfill. WisDNR has not adequately explained why sanitary landfill requirements are necessary for the disposal of dredged sediment.
   The proposed rule allows the WisDNR to exempt individual dredging projects from certain requirements of the solid waste statues. Both harbor and environmental interests continue to have concerns regarding the lack of specificity in the proposed rule relating to how the exemption and plan review decisions will be made.
3. The question of cost—how much and who should pay—has not been addressed. WisDNR response is to say that the solid waste disposal statues are based on disposal of solid waste rather than generation of solid waste. Therefore, WisDNR explains, the sponsor of the dredging bears the burden. This response totally ignores the uniqueness of dredged sediment and the fact that contamination is usually generated by a variety of interests whose direct or indirect disposal of the contaminant into the harbor is often illegal.

These rules are so stringent that the Corp of Engineers has stated that if a sponsor complied with all the technical requirements, submittals, coordination, management, approval, and disapproval criteria, it would be unlikely that a major confined disposal facility could be built in a decade *or at all* in the state of Wisconsin. These rules, in combination with new cost- sharing requirements of the federal government, threaten the survival of commercial shipping in Wisconsin.

In the eyes of the transportation industry, our state has not done a thorough evaluation of dredge disposal options. We have focussed only on protection of the resource and have done so by categorizing all dredged material regardless of the degree of contamination as solid waste potentially subject to regulation under the

Resource Conservation Recovery Act. This position ignores the potential benefit of using dredged material to build beaches and slow erosion, to restore the littoral drift budget, or to create islands for recreational and wildlife use.

Resource management means more than protection. It demands a consideration of potential human uses and benefits as compared to the risks to environmental quality. Wisconsin is presently in the midst of resolving this dredge disposal dilemma. As a leader in the Great Lakes in terms of having extremely high standards and requirements for environmental protection, we are being carefully watched by other Great Lakes states and will possibly serve as a model for them. The administrative rules which I've critiqued have been approved by our Department of Natural Resources and are now in legislative committees. The jury is still out.

Dredging Management: A Comparative Analysis of Mid-Sized U.S. North Atlantic Ports

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Abstract

Ports are vital links in the total transport system. The ability to handle changes in maritime transportation is essential for any port's economic well-being. As the world's merchant fleet of larger, deep-draft vessels increases, the importance of dredging U.S. ports to accommodate them is apparent. Dredging and maintenance of adequate channels, approaches and anchorages is a matter of major concern for ports that wish to provide efficient service and remain competitive.

Dredging management within the states of Rhode Island, Maine and Connecticut is examined through an analysis of the ports of Providence, Portland and New Haven. These ports were selected from a field of 30 Atlantic Coast ports through a multivariate statistical analysis, based on similarities in size, function and geography. Each port's dredging history was compiled to quantify the frequency and magnitude of dredging activity among the three states. Pertinent state laws, regulations and policies regarding dredging and dredged material disposal were reviewed in an attempt to identify similarities and differences. It was believed that differences among each state's regulatory frameworks concerning dredging activities would lead to variations in each state's dredging management. While variations do exist among each state's regulatory framework, it was determined that these differences only caused minor variations in processing time for dredging permits. The results of this research indicate that it is the availability of suitable disposal sites, and not variations among state-level dredging regulations, that is the main controlling factor with regard to effective dredging management.

Classification of Atlantic Coast Ports

Port-to-port comparisons are of value for both broad analytical purposes and specific evaluations such as dredging activity. Data collected and compared from various ports facilitates a meaningful assessment of port efficiency. For purposes of this study, 30 Atlantic Coast ports are classified through a multivariate analysis involving three major criteria: size, function and geography. By combining criteria, it is possible to develop a more meaningful comparative picture.

Cluster analysis is utilized for this classification due to the necessity of dividing a set of objects (ports) into subgroups which differ in meaningful ways. Kachigan (1986) defines cluster analysis as a set of techniques for accomplishing the task of partitioning a set of objectives into relatively homogenous subjects based on inter-object similarities.

The variables utilized in the final cluster analysis were total bulk tonnage, maximum harbor draft, and total vessel trips requiring channel depths of at least 35 feet. These variables are determined to be the most important with regard to classifying ports for the purposes of a comparative dredging management study. Table 1 shows where the 30 ports were placed by the final three-variable cluster analysis.

TABLE 1

CLASSIFICATION OF ATLANTIC COAST PORTS

PORT SIZE	PORTS	
SMALL PORTS:	Richmond, VA	New Bedford, MA
	Bridgeport, CT	Georgetown, SC
	Brunswick, GA	Fall River, MA
	Albany, NY	
MEDIUM PORTS:	New London, CT	New Haven, CT
	Palm Beach, FL	Miami, FL
	Port Canaveral, FL	Port Everglades, FL
	Jacksonville, FL	Searsport, ME
	Portland, ME	Portsmouth, NH
	Charleston, SC	Wilmington, DE
	Wilmington, NC	Morehead City, NC
	Providence, RI	Newport News, VA
	Camden, NJ	
LARGE PORTS:	New York, NY	Savannah, GA
	Baltimore, MD	Norfolk, VA
	Boston, MA	Philadelphia, PA

Within the medium-sized grouping three ports: New Haven, Connecticut, Providence, Rhode Island, and Portland, Maine are the most similar with regard to the variables compared. These very similar ports were ultimately chosen for the comparative dredging management study. Since all three ports are primarily liquid-bulk ports, deep-draft tanker traffic is common. Thus, the construction and maintenance of deep channels and berths are a necessity for port efficiency.

Dredging Histories

Dredge project inventories were compiled for New Haven, Providence and Portland in order to quantify the frequency and magnitude of dredging projects within each port. All completed construction and maintenance projects since 1970 were included.

Dredging can be divided between federal and local projects. Federal projects deal mainly with the construction and maintenance of major access channels turning basins and emergency anchorages. On the other hand, local projects deal with the construction and maintenance of privately owned berths and minor access channels.

The most significant findings within the dredging histories involved the local projects. Since 1977, 22 local projects were completed in Portland, and 27 similar projects were completed in New Haven. However, during the same time span, only eight local projects were completed in Providence. It is important to note that these ports were chosen for their similarities in characteristics. Further research on dredging activities in Providence indicated a lack of suitable disposal sites in Rhode Island.

Comparison of State Regulatory Frameworks

The regulatory frameworks concerning dredging activity for the individual states of Rhode Island, Maine and Connecticut were examined. Important state laws, regulations and policies were reviewed along with the agencies who administer them.

The regulatory process involves a considerable amount of coordination between the Army Corps, various state agencies and the applicants themselves. The amount of coordination that occurs between the involved parties greatly influences the efficiency and effectiveness of the regulatory process. Improving coordination between state and federal agencies has been a goal for all three states. As a direct result, the regulatory processes of these states have many similarities. However, variations among the states are also widespread.

A review of the dredging regulations of these three states revealed five main similarities. First, all three states require approximately the same information on their permit applications. However, Rhode Island's Coastal Zone Management Plan does spell out the informational requirements in the most clear and comprehensive manner. Second, all three states require that water quality certification be obtained prior to permit approval of any dredging activity. This authority was delegated to each state under the provisions of the Federal Water Pollution Control Act Amendments of 1972. Thirdly, all three states have similar criteria for bulk sediment tests when analyzing and classifying dredged material. Bulk sediment analysis is important because the results are used to determine which disposal options are environmentally safe.

The fourth similarity found was the unanimous support of necessary maintenance dredging, provided the projects take place in an environmentally sound manner. Finally, the fifth similarity regarding dredging regulations among the three states was the comment period following public notice of any project. Any comments concerning a specific project are to be accepted for a standard period of one month.

Review of the three state's regulatory frameworks also revealed the existence of many variations. The following eight differences were identified:

1. Only Rhode Island requires that applicants finance an environmental monitoring program if dredged materials are to be disposed of in open water.
2. While Maine has six different State statutes as well as the State Coastal Plan to administer, Connecticut only has three statutes and its Coastal Area Management Plan to address. Rhode Island is even more organized with respect to dredging regulations. Only one Act other than the State's Coastal Resources Management Program must be addressed. Rhode Island has the most clearly defined set of dredging related regulations among the three states.
3. Only Maine offers a joint application form with the Army Corps of Engineers. This insures concurrent review by state and federal agencies and eliminates duplication of effort. Both Connecticut and Rhode Island have separate state forms that must be filed along with Army Corps applications. Both states do encourage submitting these forms simultaneously to promote concurrent review. However, there is still duplication of effort which may slow down the regulatory process in some cases.
4. Only Connecticut offers joint public notice with the Army Corps of Engineers for dredging projects. Once again, any step taken to improve cooperation be-

tween the Army Corps and a state's decision-makers will decrease regulatory processing time. Maine has experimented with joint public hearings and has had great success. They are encouraged whenever possible. In Rhode Island, the Coastal Resources Management Council sends public notices to all interested parties separately from Army Corps notices.

5. Another variation among the individual states exists with regard to general policies within each state's coastal zone management plan. Both Maine and Rhode Island give high priority to new water dependent development on their ports, as long as any development in the coastal area is environmentally sound. On the other hand, Connecticut's Coastal Plan does not give port development as high a priority. Connecticut's policy calls for discouraging dredging of new federal navigation channels, basins and anchorages. This policy appears to block the port industry from expansion by encouraging the industry to take advantage only of existing and authorized water depths. Connecticut's Plan appears to favor environmental conservation, while both Maine and Rhode Island have a more balanced coastal plan. Concern for the State's shellfish habitat has been a major reason for recent delays in the proposed New Haven Harbor navigation improvement project.
6. In addition to the required permits, the states of Connecticut and Maine have one additional requirement. Both require permission from the local board of Harbor Commissioners prior to dredging activity. Rhode Island does not have any such local entity.
7. Only Connecticut has designated one person within State government as the dredging coordinator. The dredging coordinator is the liaison between the State and the Army Corps, especially when the Corps requests additional information. This line of communication has improved Connecticut's relationship with the Army Corps. Neither Rhode Island nor Maine has a specific liaison.
8. Of the three states, only Maine has the power, after considering local opinion at proper hearing procedures, to override local opposition to any project.

It is very difficult to determine which state has the most effective framework. The difficulty lies in that each proposed dredging project is a unique situation. Every project has one special circumstance or another. Generally, each state has made improvements in coordination among the applicant, the state, and the Army Corps in an effort to speed up the regulatory process. Even though regulatory variations do exist on the state level, when provided with comparable disposal options, similar projects in the individual states would be handled in the same time frame and manner. The lack of a suitable dredged material disposal site in Rhode Island appears to SIGNIFICANTLY INHIBIT dredging practices in the State.

Conclusion

The results of this research indicates that the main controlling factor regarding dredging management is disposal site availability for dredged material. Presently, neither Maine nor Connecticut have a problem with availability of suitable disposable sites. Both states have approved open water sites, which receive the majority of their dredged material. On the other hand, the State of Rhode Island closed its Brenton Reef disposal site in 1971, and no suitable site has been approved since. This has created a major problem for dredging management in Rhode Island.

By maintaining suitable open water disposal sites, both Maine and Connecticut have assured that dredging will remain an ongoing activity enabling economic growth to continue within their port and maritime transportation industries. Rhode Island's port industry will remain at a serious disadvantage until the State designates a suitable disposal site.

References

Kachigan, Sam Kash. (1986) *Statistical Analysis: An Interdisciplinary Introduction to Univariate and Multivariate Methods.* New York: Radius Press, 1986.

The Next Generation Water Level Measurement System and Its Applications

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Introduction

For well over a century the National Ocean Service (NOS) has been monitoring water levels, for which it provides numerous products and services. If a question involves "how high" or "how low" from an earthly reference point, the answer intrinsically includes results of water level measurements.

To carry out its responsibility for monitoring water levels and collating results, NOS maintains a network of stations along the coasts of the United States, including the Great Lakes, and in the Trust Territory of the Pacific Islands. This National Water Level Observation Network (NWLON) numbers about 200 permanent stations and 100-150 temporary stations each year.

Until about 20 years ago, all data processing and analysis was performed manually. Introduced at that time was a digital binary coding measurement device that would record data on a punched paper tape that was computer compatible. However, the method of sensing the fluctuation of water level has been virtually unchanged for roughly the past 140 years; consisting of a stilling well with a constricted opening to mechanically filter the short period wave motion at the site. This damped motion inside the well is sensed by a float connected by stainless steel cable to the recorder on a pier above. Through gears and springs, the vertical motion of the float is translated into a binary coded height which is recorded every six minutes as an instantaneous measurement punched into a paper tape. Five days each week an observer visits the station to complete several tasks. They are to: check instrument operation, record a manual water level measurement from a tide staff, measure and record the water temperature and density with a thermometer and hydrometer, observe and record other information. Data tapes and the other information are mailed monthly to NOS headquarters. These data pass through processing, analysis, and archiving operations which are quite labor intensive, requiring considerable manual intervention throughout the process from incoming new (or raw) data through finished products and information. Depending on data quality, the processing and tabulation steps usually are completed from one to three months after data collection. For complete summarization and review, and for verification of geodetic levels and bench mark elevations, over a year may pass.

Increased requirements for improved quality and availability of data with reduced man power has given impetus to creating the Next Generation Water Level Measurement System (NGWLMS). This involves an entirely new state-of-the-art redesign of NOS' water level monitoring activities. The program objectives of NGWLMS are intended to solve virtually all of the shortcomings of the present systems regarding data collection, analysis, quality control (QC), and dissemination.

At each of the NWLON stations all of the sensing, measuring, and recording instrumentation will be replaced with a new Data Collection Platform (DCP). It will have an acoustic water level sensor to measure water level fluctuations. Also, there will be a backup water level measurement system to assure continuous data collection. The DCP will have the capability to measure and record ancillary parameters such as wind speed and direction, barometric pressure, current speed and direction, and water density and temperature. Each DCP will transmit its accumulated data every three hours via the Geostationary Operational Environmental Satellite (GOES) to the National Environmental Satellite, Data, and Information Service (NESDIS), which will then forward the data to the computer system in Rockville, Md. Automated quality control features of the data acquisition function will examine data as they are received, and flag and report any problems. The data acquisition function will pass these data into the Data Base Management System, at which time other auto-mated processing and analysis functions will be performed.

NOS expects that more than 90 percent of incoming data will pass through the automated QC and analysis functions to become available for use within moments after receipt. Data will be updated and usable in near real-time; i.e., within a few hours after being collected by the field system. Most of the labor intensive manual tasks will be relieved by the new automated techniques. Regular products that traditionally have not been available until months after data collection will be available much sooner.

Field Unit for the NGWLMS

The primary water level sensor for the NGWLMS is a self calibrating air acoustic sensor, which typically will sample water height 181 times in a 3-minute period centered about a 6- minute interval. This sampling is accomplished by timing an acoustic signal which is sent down a 1/2 inch diameter tube, reflects from the water surface, and returns to the sensor head. The tube is enclosed in a protective well six inches in diameter. The DCP software computes a mean and standard deviation of the sample, removes outliers beyond three standard deviations from the mean, and computes a new mean and standard deviation which are stored along with the number of outliers removed from the original sample set.

The DCP is a 16 bit microprocessor based system which collects and stores data from a variety of sensors. The system stores up to 30 days of data in internal memory for transmission over the GOES or telephone line, or by direct connection to the DCP.

The backup water level measurement system will operate separately from the primary (air acoustic) sensor. This system consists of a pressure type water level sensor and a self contained data logger. Its measurements will be made in the same sampling scheme, and a stored measurement will be determined in the same way; i.e., computing mean, standard deviation, etc. as the primary water measurements.

Ancillary sensors may be incorporated into the field unit configuration. The basic field unit configuration which is being installed has a primary water level sensor, a backup water level sensor, and a water temperature sensor. At this time, funding restrictions limit what ancillary sensors NOS is able to include on its basic operational units. Nevertheless, NOS envisions using a standard suite of meteorological sensors to measure air and water temperatures, wind speed and direction, and barometric pressure at several of our stations.

The field unit transmits the data collected at three hour intervals to the GOES satellite which relays it back to the receiving station at Wallops Island, Va. NESDIS passes the data through to our DEC computer system.

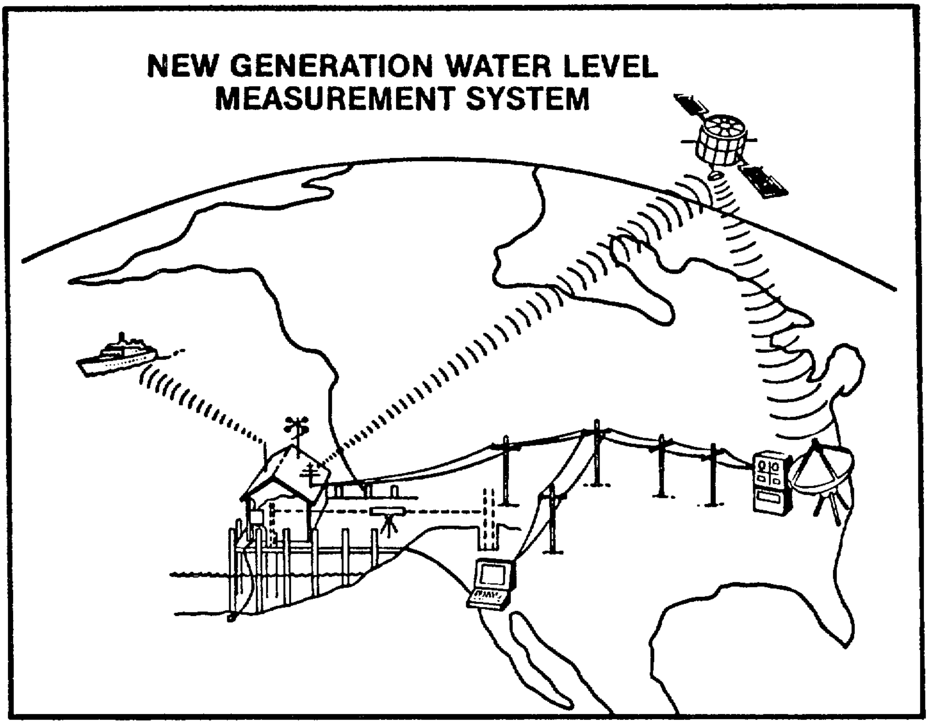

Figure 1. NGWLMS

Alternate data acquisition modes are also included. At stations where telephone service is available, the DCP can be accessed and interrogated by phone. This is intended to be the alternate method of communicating with the DCPs if problems are experienced with the GOES data telemetry. RS-232 ports are incorporated into each DCP so that field personnel can access the DCP using portable lap top computers. It is possible that other RS-232 connectable devices might be used for data transmission, such as VHF radio. See Figure 1.

Data Processing and Analysis Subsystem

The heart of the Data Processing and Analysis Subsystem (DPAS) is a relational database management system (RDBMS) from SYBASE, Inc. operating on a DEC VAX 3600 Server System; with on line storage for 10 Gb of data. The RDBMS will be accessed through the host system, a DEC MicroVAX II.

NESDIS will relay transmitted data in a nearly continuous mode directly into the MicroVAX II where the DPAS software performs its numerous tasks in the process of receiving, verifying, performing quality control checks, analyzing, and storing the data.

User access to the DPAS will be through terminals connected directly to the Data Communication System (DCS), or through Public Switched Telephone Network (PSTN) and modems connected to the DCS. The DCS also handles system interaction with other peripherals such as printers and plotters. Most user access will be by NOS personnel. However, for the first time, this new system will permit outside user access.

Data and information available through the NGWLMS will be obtainable in the following ways:

1. By mail; This has been the traditional means of providing information. The user can request, on a one-time or a subscription basis, hard copy of our products, such as hourly heights or times and heights of high and low waters by calendar month. Magnetic tape output will continue to be available. Other one-time products tailored to specific requests will also be available.
2. By PSTN link; With prearrangement, through either a one time request or a subscription, a user will be permitted access to read specific data through password control using his own computer system connected to the DPAS computer through a modem.
3. Near real-time access to DCP; This will not be available to the general public. It will only be available to those whose special needs are acknowledged through specific formal written agreements between NOS and the user organization. This will involve a telephone link to certain DCPs.

Applications for Ports and Harbors

Historical and near real-time water level data are needed for many applications relating to ports and harbors. The nautical chart and predictions of tides and currents are perhaps the most essential tools for the mariner maneuvering in a waterway. The new technology will allow almost up-to-the-minute information to supplement those basic tools. Near real-time water levels can be used to adjust plans or schedules that were made using the predictions.

The base of historical data is important for legal issues. When a ship has an accident; e.g., grounding, collision, or spill; the insurance company, Coast Guard, and port authorities want to know the tidal conditions prevailing at the time. This information often is certified for use in courts of law.

Federal, state and private coastal and marine boundaries are determined from tidal datums. Tidal datums are computed from historical data.

There are numerous engineering applications which require historical data and water level datums. Construction of piers and jetties, bulkheads and groins, bridges and tunnels, water intakes and storm drains, etc., all need datum references and information about extreme water levels. There is a growing awareness of apparent sea level rise, and a concern for its impact on the coastal environment. This must be monitored closely and accurately so that reasonable projections can be made for future engineering applications (Marine Board, 1987).

Waterway maintenance activities need these same historical data and datum references. In addition, the NGWLMS will be able to provide near real-time water level heights for control of dredging operations, such as channel maintenance by the U.S. Army Corps of Engineers.

Near real-time data are important for monitoring and responding to hazardous material spills and adverse weather conditions such as storm surges. Management of vessel traffic through long estuaries like the Chesapeake and Delaware Bays, and within harbors would benefit from near real-time water level and ancillary information such as wind speed and direction, barometric pressure, and currents.

Of interest to those involved in port and harbor activities is the issue of rising sea level. The NGWLMS will permit us to continue our long range monitoring of sea level so that we can project more accurate rates of change. The rate of change in sea level is not the same at all places (Aubrey and Emery, 1983), apparently rising along much of the U.S. coastline, while falling in other areas, such as southeast Alaska. The state-of-the-art technology of the NGWLMS will make it possible to provide higher quality information to those examining sea level rise.

Absolute Sea Level

Some questions to answer about sea level are: is it rising, where, how much, how fast, due to what, and with what implications to mankind locally and worldwide?

A new monitoring program has been inaugurated this year in which Global Positioning System (GPS) data are combined with water level data at selected sites to give a measure of absolute sea level (Carter, Scherer, and Diamante, 1987). Over time this will yield important information about change. Since the question of sea level rise has not been conclusively answered as to "how much" or "how fast," this program is expected to help address the effect of one aspect of apparent sea level rise, viz., vertical land movement (tectonic movement). The water level measurements inevitably include movement of the platform from which the measurements are made. When the continental margins move through tectonic activity and/or elastic response, such motion is intrinsic in each water level measurement. New state-of-the-art geodetic systems can help resolve this problem.

GPS consists of a constellation of satellites around the earth whose positions are very precisely known. Using a ground station, an observer can ascertain his

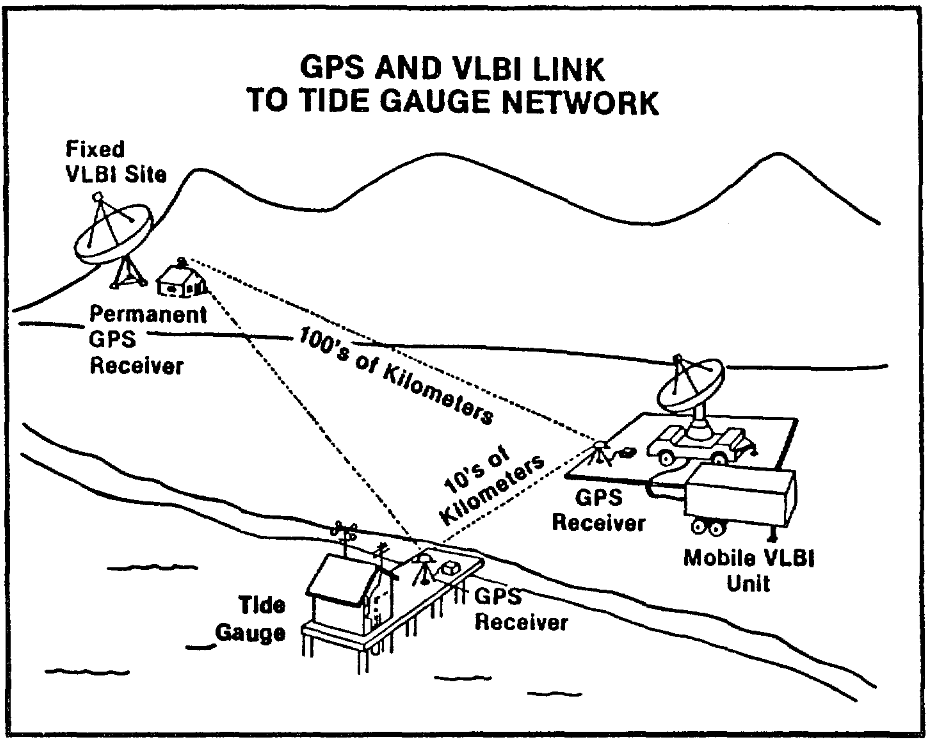

Figure 2. GPS - VLBI

position relative to a number of these satellites with an accuracy of centimeters in three dimensions. The accuracy of a GPS station position can be improved to an accuracy of one centimeter or less when operated in conjunction with a Very Long Baseline Interferometry (VLBI) station. See Figure 2.

VLBI is a highly sophisticated system which uses extra-galactic radio sources to very accurately locate positions on the earth's surface. A fixed VLBI station is a large permanent installation similar to an astronomical observatory. Measurements can also be achieved with a mobile VLBI station. Since GPS has mobile capability, a portable GPS station can be collocated with a mobile VLBI station. Another portable GPS station is then located many kilometers away, along the coast near a water level monitoring station. By differential GPS measurements the exact position of

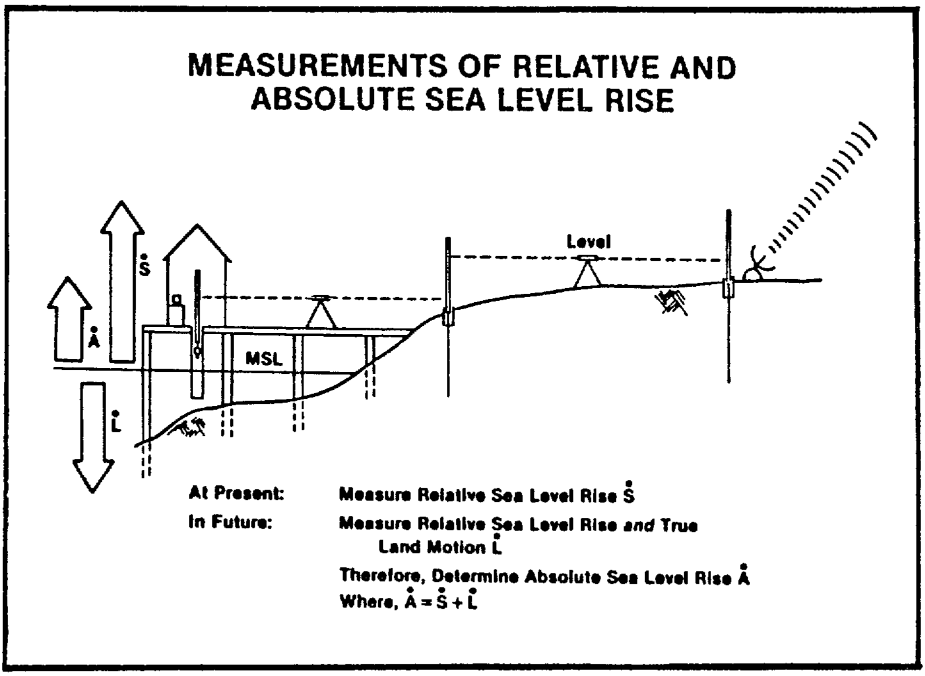

Figure 3. Absolute Sea Level Determination

the coastal station's bench marks can be determined. It is through these bench marks that the water level data can be compared to the GPS data. Thus, vertical land motion can be removed from the water level record to produce an "absolute" sea level. See Figure 3.

Decades of monitoring will pass before statistically meaningful data are accrued, but the value to climatologists concerned about the contribution of the "Greenhouse Effect" will be significant. This long term measurement program will define how much of the sea level variation is due to vertical land motion and its rate, and how much is purely sea level rise with its rate. The rates of change of water level and vertical land motion are different at various locations, and knowledge of these rates will be useful to long term coastal engineering projects.

When sea level change is more accurately quantified, answers to many questions may become evident. Resolution to political questions about who may or may not build, what may be built, where may they build will be aided by sea level information. Engineering questions would be resolved concerning what effort and cost will be required to build and/or maintain structures for, say 50 or 100 years; or, how practical might it be to build in a particular location.

Implementation Schedule

The present schedule calls for full operation of the NGWLMS by 1992. NOS has begun installing operational field units or DCPs. Installation will continue over the next three to four years. Data are beginning to be received and are undergoing temporary handling until the DPAS is implemented. By early 1989 we expect to sign a contract for software development of the DPAS which will take about three years in eight major phases from design through full implementation. By the time the entire NWLON network has been upgraded to the new field units, the hardware/- software system should be ready to handle the acquired data. As software capabilities come on line through each of the development phases they will be used operationally.

References

Aubrey, D.G., and K.O. Emery, 1983, Eigenanalysis of recent United States sea levels, Continental Shelf Research, 2(1):21-33.

Carter, W.E., Wolfgang Scherer, and John M. Diamante, 1987, Measuring absolute sea level, Sea Technology, 28(11).

Marine Board, National Research Council, 1987, *Responding to Changes in Sea Level—Engineering Implications*, National Academy Press, Washington, D.C., 148pp.

HARBOR REHABILITATION AND RECREATIONAL DEVELOPMENT IN RACINE, WISCONSIN

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History

Racine, Wisconsin is a city of approximately 85,000 people on the western shore of Lake Michigan in Racine County, approximately 30 miles south of Milwaukee, Wisconsin. Like many other industrialized cities located in the "rust belt" of the upper midwest, Racine and the smaller towns surrounding it have suffered in the past decade from the loss of jobs and businesses. In 1983, the unemployment rate reached an official high of 17%. Unofficially, the County's internal estimates put the unemployment rate at approximately 21%. Without jobs, many sought work elsewhere, leaving Racine.

In 1982, several business leaders formed the Downtown Racine Development Corporation (DRDC), for the express purpose of making a cooperative effort to stem the economic slide that was occurring and to seek ways in which to help the community recover. Representatives from S.C. Johnson (Johnson Wax), J.I. Case, Modine, Walker Forge, and the Heritage and M & I Banks where charter members in a organization that has become central to the revitalization of Racine and Racine County. Its membership having grown to 30 members, DRDC has been responsible for establishing an extraordinary environment of cooperation in which private, city, county, state and federal concerns have contributed to the creation of what is today, the largest recreational boating facility on the Great Lakes.

A shipment of road salt in 1983 was the last commercial shipping seen in Racine Harbor. With a growing realization that the Racine waterfront was under utilized, DRDC in concert with city officials, directed its attention to the harbor and downtown area immediately adjacent to it. An urban planning consultant was hired by DRDC to assist them with defining Racine's strengths and weaknesses and to develop a course of action. Among the first products of their efforts was a decision made to offer Racine's diverse and very proud ethnic organizations a site for the conduct of their annual festivals. It was decided that the revival of the downtown should begin with the assignment of a portion of the waterfront to festival activities. Planning of a festival park located along the southwestern shore began.

There had been, on many previous occasions, a great deal of talk about what might be done in Racine to improve the community and some specific ideas had even been presented. Generally, however, it was "just talk". Skepticism greeted most ideas put forth until now. Instituting the planning and design process for the festival park was the first solid sign of commitment made by the city leaders to do something. Enthusiasm for the effort grew and imaginations became active. The planning process soon expanded to consider not only the development of the shoreline, but of the harbor water surface as well.

Racine has possessed for many years, a strong recreational boating heritage. Among the members of DRDC, were some who were also members of the boating community. They had dreamed of a new marina within the harbor, and their ideas were now gaining popularity. As a result, a conscious decision was made to concede commercial shipping activity to the Ports of Milwaukee to the north and to Kenosha and Chicago to the south and to develop the harbor as a recreational boating facility. The decision to develop the harbor as a recreational boating facility was backed by an economic impact analysis performed by the Recreational Resource Center of the University of Wisconsin in Madison. Racine is readily accessible to the metropolitan markets of Milwaukee and Chicago, and demand for boat slips in these markets was high. The recreational Research Center report predicted that new boaters, mooring their boats in Racine, would bring an additional $23 million annually to the community.

It was at this juncture that Warzyn Engineering Inc was commissioned by DRDC to plan what is now a 921 slip full service marina and county park.

Plans for the water-based improvements soon grew to the extent that DRDC and the City alone could no longer handle development of the project. The County of Racine was then brought onto the team to lead the effort. The planning efforts of Warzyn Engineering, DRDC and city and county representatives resulted in a plan for development that intended to the make the harbor development the anchor for other developments in the area. What had begun as a planning effort to build a $1.8 million festival park at the waters edge, had turned into a determination to develop the harbor into a $20 million recreational boating facility and to make it one of the finest on the Great Lakes.

The Plan

The existing harbor in Racine was approximately 110 acres of water surface bounded on the north and south sides by one-half mile long concrete breakwaters and on the west by the City. The Root River flowing through the City discharged into the harbor and out of a 450 ft wide harbor entrance into Lake Michigan. The Racine Yacht Club Marina occupied a portion of the northern half of the harbor. Private boat moorings were scattered throughout the southern half and a public boat launching facility occupied the southwest corner of the harbor.

Construction of the marina and county park are now complete. The existing breakwaters were modified to improve protection against wave attack. The existing harbor entrance has been reduced to a width of 200 ft by the construction of a new stone berm breakwater extending southeasterly from the eastern tip of the north breakwater. To provide new land for park and marina related services, a confined disposal facility (CDF) has been constructed in the southern half of the harbor. Using the existing south breakwater as the south edge of the CDF and a stone berm as the north edge, 17 acres of new land has been created by filling the CDF with material dredged from the harbor bottom. The dredge work was required at many locations within the harbor, not only to provide material for the new land, but also to provide suitable water depth for the safe navigation of small boats.

A causeway from the base of Racine's Fourth Street provides access from shore to the newly created land mass. The causeway and the dredge-filled confinement structure effectively cut off access to the Lake from the existing boat launch facility located in the southwestern corner of the harbor, requiring that a new access be cut through the south breakwater into the boat launch basin. A berm structure similar to that used to protect the main harbor entrance, now protects the launch basin entrance. A 12 ft long jetty attached to the eastern tip of the south breakwater and to the new land mass, running east and west within the harbor, effectively subdivides the harbor into two halves. A 921 slip marina now occupies the southern part of the basin, well protected by the stone jetty and the dredge- filled CDF.Public and marina patron parking areas, marina administration and service facilities, a fish cleaning station, an overlook structure and the county park now occupy the newly created land mass.

Dockage for the 921 slip marina consists of two main access piers, constructed of steel pile supported precast concrete, serving as public promenades. Head walks and finger piers are floating structures, accommodating changes in the lake's water level.

Breakwater Improvements

During the planning process for the project, preliminary hydraulic studies were performed on two dimensional models of the existing north and south breakwaters, in order to assess their effectiveness and to determine what might be done to improve their performance.

Similar to a number of federal breakwaters on Lakes Michigan and Huron, the crest of the breakwaters in Racine were 7 ft above the International Great Lakes datum of zero. The static lake levels reached a record high of 5 ft above datum in October of 1986. Under lake level conditions lower than those occurring during the record high levels of 1986, storm damage resulting from severe overtopping had occurred. Extensive damage had been suffered by boats moored in the harbor, the Racine Yacht Club and other shoreline facilities.

The two dimensional model studies and the design process that followed, led to the selection of a breakwater design concept which departs dramatically from conventional approaches. Modifications to the existing north and south breakwaters and to the new entrance breakwaters, utilized a stone "berm" concept found in berm breakwaters constructed in England at the turn of the century.

The berm concept incorporates stone sizes considerably smaller than those which would result using the standard methods of design found in the Corps of Engineers Shore Protection Manual. Carefully graded stone, ranging in size from 300 to 8,000 lbs was used at Racine. The availability of material and the ease of placement are enhanced by the smaller stone sizes. The potential for finding sources of material closer to the project site, increases as the stone size decreases. This was the case at Racine. The quarry which provided material for the project is located 3-1/2 miles from the harbor. Costs for hauling the material were reduced considerably. With little exception, material placement was accomplished using a dump-and-shove operation. In Racine, over-the-road quarry trucks delivered the stone directly to the placement site for final placement by a bulldozer or backhoe.

Design of the berm breakwaters was accomplished using hydraulic modeling techniques. The berm breakwaters were physically modeled utilizing the wave tank facilities of the Canadian National Research Council Laboratories in Ottawa, Canada.

Prior to the modeling work, test blasts were performed in the local quarry in Racine in order to determine the graduation which could be derived using the standard blasting techniques normally incorporated in the quarry's operations. A uniform graduation of stone from 300 to 8,000 lbs was achieved and subsequently used for modeling and design purposes.

Wave and wind hindcasts were performed to develop the data necessary for incorporation into the modeling process. The hydrographic surveys performed during the planning process were also used to model the lake bottom conditions at Racine. The stone graduation derived by the tests performed at the local quarry was modeled by hand selection and weighing of individual pieces of stone. The modeling work was performed on models constructed at a scale of 1 to 20.

A computer controlled wave generator created wave conditions similar to those to be expected at Racine under varied design conditions. Wave conditions and direction and break water geometry were varied to achieve designs for the various structures being modeled. Constructed in accordance with the geometry determined during the modeling process to be appropriate and under actual conditions similar to the design conditions, the breakwaters were expected to reshape to a new, but stable, geometry. In February and March of 1987 storms generating waves exceeding those of the design conditions occurred. The breakwaters reshaped to the stable geometry predicted by the modeling effort.

Permitting Process

Five permits of particular significance had to be obtained for the project. A Wisconsin Pollution Discharge Elimination System (WPDES) permit, the U.S. Army Corps of Engineer's Section 404 permit for dredging and filling in navigable waters of the United States and a Section 10 permit of the Rivers and Harbors Act of 1989 were obtained. In addition to the acquisition of the above permits, a Section 401 Water Quality Permit and a Solid Waste Disposal Waiver had to be obtained from the Wisconsin Department of Natural Resources.

Acquisition of the permits could have been a long and protracted process had it not been for two major events. First the State of Wisconsin granted the lake bed, bordered by the breakwaters and shoreline bulkhead to the County of Racine. This legislative act eliminated the need to address Wisconsin Chapter 30 statues related to the disposal of solid waste (in Wisconsin, dredge material is interpreted to be solid waste) and paved the way for issuance of the Solid Waste Disposal Waiver. The second event that occurred was deauthorization of the harbor as a federal project by the Congress of the United States. This act made it possible for the Corps of Engineers to issue its permits because the harbor no longer had to be maintained for commercial shipping. Additionally, the time necessary to obtain the Corps of Engineer's permits was shortened dramatically. There is, however, a negative aspect to deauthorization. The County of Racine now owns and must maintain the harbor. They accepted the trade off.

Project Funding

Exclusive of the marina and its associated facilities, (administration building, two service buildings and a fuel service building) the harbor improvements portion of the project cost $11 million. Supplemented by approximately $1.5 million in city funds and grants from the Economic Development Administration, the Community Block Development Program and the Wisconsin Waterways Commission, the County issued bonds to fund the harbor project.

The cost of the marina was $9 million and was originally intended to be funded by the County through the issuance of revenue bonds. During its construction, however, private marina operators came forth with unsolicited proposals offering to complete the development of the marina. A private operator now owns and operates the marina facilities, leasing the lake bed and land occupied by the marina facilities from the County.

The Seaway Trail Linking New York's Great Lake's Ports and Harbors

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The American Tradition of Scenic Motoring Trails[1]

The New York Seaway Trail represents both the continuation of an American tradition and its rediscovery. Since the spread of automobile ownership in the U.S., scenic routes have periodically been a focus of planning and construction activity at the local, state, and federal levels (Jackson, Kihn 1988).

Touring routes deliberately designed to display natural wonders and scenic landscapes began to be built soon after the turn of the century. As part of Frederick Law Olmsted's plans for the Back Bay in Boston, 78 miles of parkway were built between 1877 and 1930. Other early eastern parkways include those in Westchester County, New York, built between 1913 and 1930—the Bronx River, Hutchinson River, Saw Mill, and Cross County Parkways (US Department of Commerce 1966). Among the earliest in the western U.S. were Oregon's Siskiyou Highway, completed in 1914, and the Columbia Gorge Highway, begun in 1914 (Santini 1987).

Several interstate touring routes were begun in the 1930s, partly as a continuation of the earlier impetus and partly as a Depression era measure to create jobs. The 470-mile Blue Ridge Parkway (begun in 1935) and the Natches Trace (1939), both managed by the National Park Service (NPS) are examples of this. The Great River Road, which traverses ten states from Minnesota to Louisiana, was also conceived of during this period. Scenic routes such as these were seen as a type of linear park. As the history of the Blue Ridge Parkway states:

the 'scenic highway' concept evolved into an elongated park containing a road designed to please motoring viewers by revealing the beauty, charm, and interest of a portion of the native American countryside (ibid).

The Rediscovery of Scenic Touring Routes

Since the 1950s, the nation's 43,000-mile, high speed, interstate system has been the focus of highway programs. However, in recent years the possibilities for conservation, recreation, and economic development represented by older, more leisurely routes have not been forgotten.

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[1]Excerpts form the draft Seaway Trail Tourism Development Plan (Jackson, Kihn, 1988)

Proposal for a nationwide system of scenic byways

A 1966 report to the President's Commission on Recreation and Natural Beauty prepared by the U.S. Department of Commerce recommended a national, $4 billion program of scenic roads and parkways based on Americans' demonstrated interest in driving for pleasure and the potential for substantial economic benefit in the form of tourism development.

More recently, interest in scenic roads has been expressed by the President's Commission on Americans Outdoors, a blue ribbon panel established by Presidential Order in 1985 to recommend ways to meet the country's growing recreation needs into the next century. In the Commission's 1986 report, one of twenty major recommendations was the creation of a network of "scenic byways composed of scenic roadways and thoroughfares throughout the nation". According to the report, over 43 percent of American adults consider pleasure and tour driving a primary recreational pastime—second only to walking. Criteria is suggested for these scenic byways, which would be eligible for federal matching funds, include the presence of examples of the nation's historic, pastoral and natural heritage; scenic views; and accessible recreation facilities and opportunities (President's Commission on Americans Outdoors 1986).

The Highway Users Federation has held nationwide field hearings throughout 1987 and 1988 to determine the public consensus for modifications to national highway policy and funding program. Among the questions being considered is what support exists for redirecting federal highway funds to the upgrading of secondary roads once the interstate highway system is completed in the early 1990s. Were this redirection to occur, substantial funds would be available for the upgrading of scenic routes throughout the country.

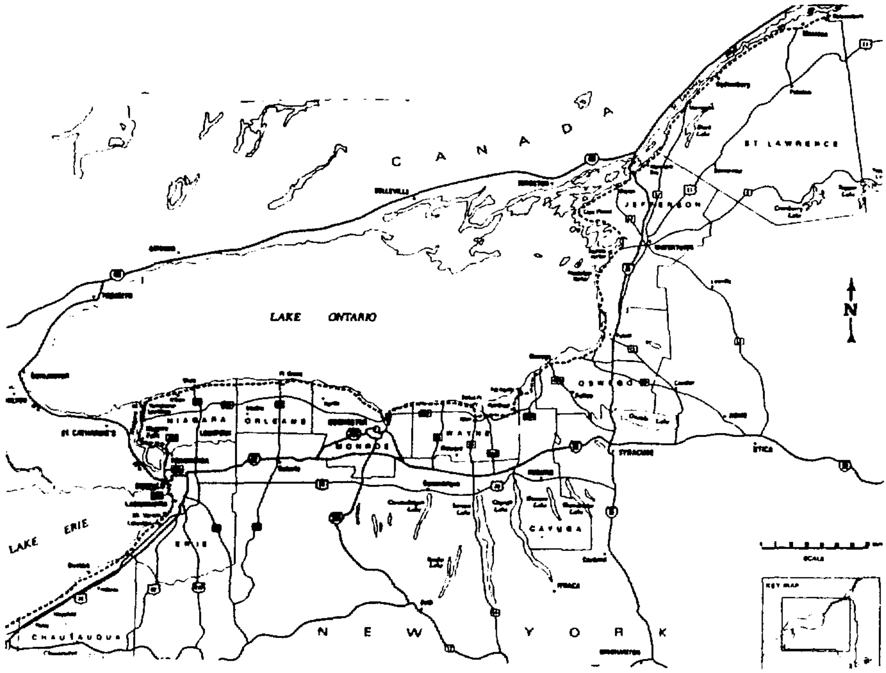
The Seaway Trail

The Seaway Trail is 454 miles long, stretching from Rooseveltown on the St. Lawrence River to Ripley on the New York-Pennsylvania border. The Trail connects the St. Lawrence River, Lake Ontario, the Niagara River, and Lake Erie (Figure 1). It also ties commercial ports, such as Buffalo, Oswego, and Ogdensburg, together with numerous recreational harbors.

Creation of the Trail

The establishment of the Seaway Trail resulted from the same kinds of concerns for the preservation of natural beauty and the development of recreational opportunities as many of the earlier scenic routes. Three reports issued in the mid-1960s recognized the possibilities of the recreational corridor along what is now the general route of the Seaway Trail. The 1966 report from the U.S. Department of the Interior, entitled *Trails for America*, recommended the creation of a 2,000-mile long loop called the Great Lakes International Trail, which was to include a segment along the southern edges of the St. Lawrence, Lake Ontario, and Lake Erie. In the same year the U.S. Commerce Department study, mentioned earlier, recommended the Seaway Trail route between Massena and Niagara Falls for inclusion in a national system of scenic roads. This nomination, in turn, derived from New York's own 1965 study of potential scenic roads.

National and state recognition of the potential of such a route was undoubted-



ly a factor in a proposal by the late William E. Tyson, then Executive Director of the St. Lawrence-Eastern Ontario Commission (SLEOC) to develop a road network focusing attention on the shoreline region of Lake Ontario and the St. Lawrence River. SLEOC designed signs and determined their placement. The State Department of Transportation (DOT) supported these efforts. This proposal was pursued in the State Legislature, which approved a bill that defined the Seaway Trail as extending from the Roosevelt International Bridge to Fair Haven. by May, 1978, the New York State DOT placed Seaway Trail signs along this portion of the Trail.

In June, 1980, the Seaway Trail was extended to include the area between the Rainbow Bridge in Niagara Falls and Fair Haven. In 1982, SLEOC prepared a development prospectus to inform those along the Seaway Trail of the benefits of the Seaway Trail and to encourage them to plan for increased development. In that same year, as a result of an NPS study of the St. Lawrence-Thousand Island area, the concept of including the Seaway Trail as a National Recreation Trail (NRT) was pursued.

The application for NRT status was made by the State DOT, as the owner of the "Trail" right-of-way. This application was supported by the State Office of Parks, Recreation and Historic Preservation (OPRHP) and by the Seaway Trail communities in the 360-mile stretch between Niagara Falls and Massena. In July, 1984, this section was dedicated as an NRT. Just two weeks later, Governor Mario Cuomo signed legislation to further extend the Seaway Trail from Niagara Falls to Ripley at the Pennsylvania border. In December, 1986, this second section (94) miles was was dedicated as an NRT in a ceremony at the Theodore Roosevelt Inaugural National Historic Site in Buffalo.

Seaway Trail, Inc.

In October, 1978, Seaway Trail, Inc. was formed as a not-for-profit corporation with five directors. Dr. Vincent Dee, President of Seaway Trail, Inc., has been a leader in building regional support for the Trail over the last ten years. Trail supports in the State Legislature have included former Senator Barclay, Assemblymen Zagame and Murphy, and Senator McHugh.

By 1983, Seaway Trail, Inc. had adopted bylaws. In 1986, the organization received a $250,000 appropriation from the State Legislature, funded through OPRHP, and established an office in Oswego with a staff of three full-time employees. In 1987, Seaway Trail's appropriation was increased to $300,000 and for 1988, to $500,000. A portion of this 1987 appropriation was used to fund an inventory of tourism resources along the Trail and to prepare a tourism development plan.

The stated purpose of Seaway Trail, Inc. is to gain recognition for the shoreline region of Lake Erie, Niagara River, Lake Ontario, and the St. Lawrence River as a major tourism region within New York State. International recognition of the Trail as New York's prime historic and recreational trail and regional economic development through the growth of the tourism industry are related objectives.

The staff of Seaway Trail, Inc. consists of an Executive Director, a Recreation/Tourism Planner, a Trail Operation Coordinator, a Marketing/Design Specialist, and three Regional Sales Representatives. Staff members focus on: promotion, marketing, and planning for the Trail's ten-county area; educating the public about the Trail; raising awareness of it as a unified vacation area; building support for tourism through membership in Seaway Trail, Inc., and developing a Trailwide signage system (see Figure 2).

Promotion and Visitor Information

The prospective visitor receives information about the Seaway Trail through a range of media channels, through promotional agencies (such as the NYS Department of Economic Development's I Love NY program and ten-county region). Seaway Trail promotional material takes the form of brochures, maps, booklets, magazine articles, magazine inserts, sponsor kits, press releases, and videotapes.

In cooperation with SLEOC, Seaway Trail, Inc. has developed a series of publications for the eastern four counties of the Trail—a bicycling packet (Bikecentennial, Inc. 1986), as well as a series of booklets on the region's geology (Muller and Pair, 1986), and architecture (Hatchison, 1980). An interpretive guide to the Trail's War of 1812 (Wilder and Wilder, 1987) sites is also available.

Currently being developed is a system of unmanned information and kiosk displays to be placed at sites along the Trail and which are designed to inform the tourist of the major features of the Trail in that area. Eleven Trail displays/kiosks are now in place with 20 more to be completed by the end of 1988. Another 20 or more are planned for installation in 1989 (See Figure 3).

In addition to these day-to-day promotional functions, Seaway Trail, Inc., directors, members, and staff develop strategies for short-and long-term development and promote trailwide planning and events. For example, Seaway Trail, Inc., sponsored the visit of the Rattlesnake, a tall ship, to coincide with festivals at seven ports and harbors in the summer of 1987.

In 1989, Seaway Trails, Inc., will publish Journey, a 96-page magazine. This

Figure 2. Seaway Trail Logo and War of 1812 Interpretive Signs

magazine will include travel feature stories and paid advertising. A total of 250,000 copies will be printed and will be distributed via direct mail, in hotel rooms, at information centers, chambers of commerce, tourist promotion agencies, and at consumer shows.

Planning

Seaway Trail, Inc., has established a planning committee to coordinate and oversee the organization's efforts in planning and research.

Prior to 1985, some of the planning activity was initiated by the St. Lawrence-Eastern Ontario Commission. For instance: In 1982 SLEOC prepared a development prospectus to inform those along the Seaway Trail of the general intent and direction of tourism development. In 1984, SLEOC commissioned a Trail Tourism Development Plan (MacDonald, 1984) for a section of the trail between Massena and Fair Haven in order to take a comprehensive look at coordinated development of the Trail involving both public agencies and private groups. This effort was complemented by a study of the signage system (both existing and proposed) for the eastern section of the Trail in 1985 (Smardon et al, 1985). The objective of the signage study was to examine the functionality of existing signage, develop standards, and propose other methods of communicating Seaway Trail information.

Another study dealt with the question of documenting and suggesting land use management techniques for maintaining visual access from the Trail to open water areas in 1984 (Smardon et al, 1984,1987). A major issue was the effect of local uncontrolled land use development and its effect on the quality of views and visual access to the St. Lawrence Seaway.

In 1985, Seaway Trail, Inc., adopted official themes for the Seaway Trail based

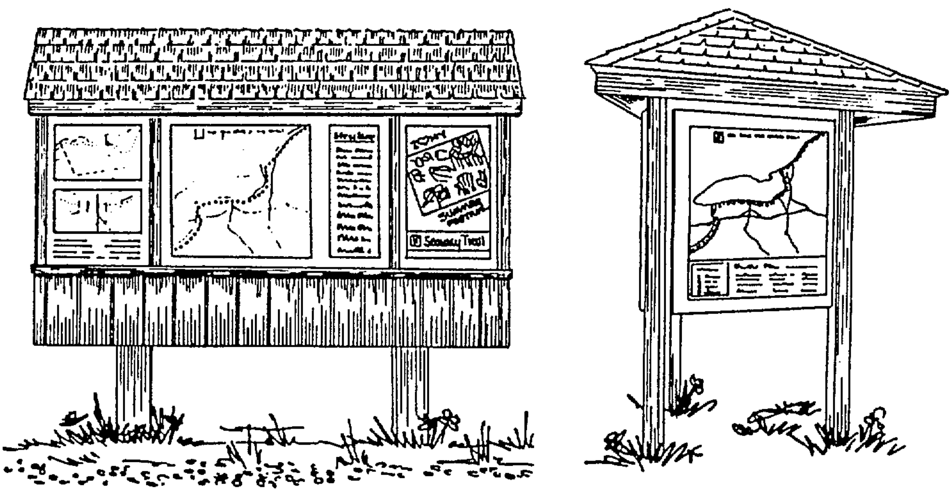


Figure 3. Seaway Trail Tourism Information Display Board (Flat) and Kiosk (3-Sides) Structures

on the planing committee's survey of the directors and members. The marketing theme adopted is "Trail along the Great Lakes/Inland Seaway". Eight resource themes related to this marketing theme are: *Coastal Recreation and Tourism, History of the Coast, People of the Coast, Commercial Shipping, Natural Resources of the International Coastline.* These official themes are currently interpreted in various ways along the Trail and provide a basis for future promotion. Much effort was focused on ensuring that the Trail was in the right location to afford visual and physical access to water related attractions, ensuring that appropriate road signage and tourism information was available, designating attractions and themes as well as potential loops, spurs, and walking tours within those themes.

In 1987, the Board of Directors of Seaway Trail, Inc., decided that the best approach to coordinating the region's development for tourism was to commission a conceptual framework plan which would identify Trailwide opportunities and a common direction for development. This framework plan was to be followed by more specific development plans for different parts of the Trail region. The plan is presently nearing completion. A summary of the plan will be available by writing:

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References

Bikecentennial, Inc. 1986. *Seaway Trail Bicycling*. St. Lawrence- Eastern Ontario Commission and Seaway Trail, Inc., Watertown and OSwego, NY.

Hutchinson, E.E. 1986. *Along the Trail and Into the Past: Architecture and History Along the New York State Seaway Trail*. St. Lawrence-Eastern Ontario Commission, Watertown, NY.

Jackson, Joanne, and Cecily Kihn. 1988. *Seaway Trail Tourism Development Plan* - Draft. Prepared for Seaway Trail, Inc.

McDonald, D.B., et al. 1984. *On the Seaway Trail: The Seaway Trail Tourism Development Plan*. St. Lawrence-Eastern Ontario Commission, Watertown, NY.

Muller, E.H. and D. Pair. 1986. *Seaway Trail Rocks and Landscapes*. St. Lawrence-Eastern Ontario Commission, Watertown, NY.

President's Commission on Americans Outdoors. 1987. *America's Outdoors, The Legacy, The Challenge*. Island Press, Washington, D.C.

Santini, James D. 1987. Scenic Byways: A National Treasure. *Courier*. November.

Seaway Trail, Inc., Planning Committee. 1987. *Seaway Trail Themes*.

Smardon, R.D. 1987. Visual access to 1,000 Islands. *Landscape Architecture*, Vol. 77, No. 3, pp. 86-91.

Smardon, R.C., V. Furmanec, J. Garland, and M. Rittberg. 1985. *New York Seaway Trail Sign Study*. School of Landscape Architecture, SUNY/ESF, Syracuse, NY.

Smardon, R.C., W.M. Prince and M.R. Volpe. 1984. *St. Lawrence River Scenic Access Study*. School of Landscape Paper No. ESF-84- 004, SUNY/ESF, Syracuse, NY.

U.S. Department of Commerce for the President's Council on Recreation and Natural Beauty. 1966. *A Proposed Program for Scenic Roads and Parkway*. U.S. Government Printing Office, Washington, D.C.

U.S. Department of Transportation, Federal Highway Administration. 1988. *Scenic Byways*. USDOT FHWA Publication No. FHWA-DF-88-004, USGPO, Washington, D.C.

Wilder, P. and Wilder, M. 1987. *Seaway Trail Guide to the War of 1812*. St. Lawrence-Eastern Ontario Commission and Seaway Trail, Inc., Watertown and Oswego, NY.

THE RELATIONSHIP BETWEEN PERCEPTIONS OF GENTRIFICATION AND WATERFRONT REVITALIZATION POLICIES

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INTRODUCTION

Urban waterfront revitalization has become extremely popular in recent decades. Waterfront development along the nation's coasts and rivers has often been touted by politicians and developers as a panacea that provides recreational facilities, public access, housing, employment, and aesthetic functions. Development projects have often brought new vigor and appeal to many abandoned piers and desolated areas along the waterfront.

A number of cities along the waterfront have discovered that waterfront revitalization can be a double-edged sword. Such projects, when successful, are likely to attract middle- to high-income housing. This phenomenon, referred to as gentrification, can also result in physical alterations of existing and conventional water dependent land use patterns.

Gentrification along the urban waterfront has created some unsuspected political and social developments, including the fear that high-income incoming residents and workers will irreparably destroy the social fabric of the city. Often the resident population believes its very way of life is threatened. The perception can be pervasive and may also influence political agendas and land policies.

This very fear became a factor in the 1984 mayoral election in Jersey City, NJ. The level of development, its benefits, and who receives those benefits was an important issue in the campaign. A new political administration was assembled on a ticket based on the notion that development was uncontrollable and potentially harmful, and gentrification was rampant. This administration's plan of attack was to create and maintain affordable housing in the city, including the waterfront. By enabling long-time residents to continue to live in the city, while continuing to attract new residents, the administration expected to create a vital, liveable city for all people, not just a select few.

The city, located on the Hudson River across from Manhattan, is a former industrial and marine transportation center that is in the process of being converted into mixed commercial and residential uses. Waterfront development has resulted in numerous controversial issues in the past few years, including the concern that the waterfront will become dominated by upper-class interests. In this context, Jersey City is a prototype for other industrial waterfronts that are currently revitalizing.

Despite numerous master plans and state and regional planning efforts calling for waterfront revitalization, Jersey City only began to demonstrate its potential in this decade. Currently, 30 projects are planned for the 2.4 square mile area of Jersey City known as Downtown, or the "waterfront." This represents almost half of all development along the Northern New Jersey waterfront (*On the Waterfront*, Spring 1988). Estimates suggest the city will acquire 23,476 residential units, 22,065,855 square feet of office space, 2,200 hotel rooms, 43.497 parking space, and 1,427 boat slips (Projected Waterfront Development, Urban Research & Design

Division, 1988).

Methodology

The Cucci Administration entered City Hall in 1985 because it promised to control growth and distribute the benefits of revitalization more equitably than the previous administration. This study was undertaken three years into the Cucci Administration with the expectation that perceptions and fears of gentrification remained a critical issue and were directly responsible for changes in the city policies affecting the waterfront. The purpose of this study is to assess how city officials and administrators perceive gentrification have influenced waterfront revitalization policies. Specifically, it was hypothesized that decisions made by city officials and administrators were directly influenced by the public's negative perception of gentrification. Twenty-five detailed, open- ended interviews were conducted with city politicians, administrators, citizen participation groups,waterfront developers, and media representatives. The initial target group was the city officials and administrators, who were assumed to represent the concerns of their constituency. This group, more than the others, was in a position to effect changes by creating and amending city policies.

The hypothesis would be supported if evidence was found of both negative perceptions of gentrification among city officials and administrators, and corresponding policies related to gentrification. If perceptions existed, it was expected that they would be translated into policy statements and appear in city documents, ordinances, and regulations. The results of the interviews were critically analyzed to determine how various political, administrative, and other interest groups perceive the city and its future. Once concerns were identified, city policies relating to perceptions of gentrification were examined.

Results

All participants agreed that Jersey City had improved since the 1970s. However, the extent of the improvement is uncertain. Generally, the benefits of revitalization appeared to be more frequently cited that the negative aspects, but there are strong indications that waterfront revitalization is not perceived as beneficial to all city residents.

Almost all participants described Jersey City as a blue-collar town during the 1970s. When asked what was currently happening in the city, 43 percent of the responses were positive— participants declared Jersey City was experiencing promising times and new growth. However, 26 percent noted increasing housing prices and taxes. The success of waterfront revitalization was explained as being linked to New York City. Lower rents and access to New York City were mentioned most often, followed by the prodevelopment stance of the previous Administration. Together, these reasons constituted 86 percent of the responses.

Responses concerning the positive and/or negative aspects of revitalization were mixed: 71 percent of the responses were positive, chief among them, the perception that revitalization would bring greater tax revenues. Although only 29 percent cited negative aspects, 86 percent of those responses mentioned that revitalization causes displacement, creates higher property taxes, and creates the need for more infrastructure. Two participants declared that revitalization had no negative aspects.

Participants did not seem to believe that revitalization benefitted everyone in the city. Responses indicated that revitalization often assigned exclusionary benefits (19 percent), and was potentially harmful (19 percent). Jobs created by waterfront revitalization were believed to go to outsiders, not residents (19 percent). Only 19 percent of the responses concerned benefits projected for the future. Participants also believed that the public was ambivalent about the changes taking place in the city. Forty percent of the responses given indicated that the public felt pride in revitalization and believed new opportunities and benefits were occurring, but 36 percent believed the public perceived changes negatively, and 20 percent were ambivalent.

Not one participant believed that the public perceived gentrification positively: at best, 28 percent of the participants believed that the public might give a positive response, depending on who was asked, while 69 percent believed the public perceived gentrification negatively. Chief among the reasons given for this perception was that not everyone benefits equally from revitalization.

Gentrification appeared to have a negative connotation, perhaps reflective of past abuses of fears. Signs of gentrification as described by participants were generally negative. Almost half of the signs concerned items such as increasing landlord abuses, homelessness, factory closings, increasing condominium conversions, and increasing property taxes.

Participants believed revitalization would improve the city (19 percent), 15 (percent) believed Jersey City would become an extension of New York City, and 12 percent indicated housing problems. Forty-one percent believed that the differences between the waterfront area and the rest of the city might create two separate cities, namely, the rich waterfront area, and the poor inner city. Thirty-five percent were convinced the waterfront could never disassociate itself from the rest of the city, and 18 percent of the responses stated the waterfront would become distinctive.

Discussion

The results of these interviews suggest that the waterfront revitalization experience in Jersey City may not be perceived in the most positive light for the city as a whole. The results of the interviews indicate that participants believe the public defines gentrification negatively and considers it a threat. Benefits appear to be diffused, at best, and costs are difficult to assess. The city officials and administrators were more concerned with numerous other problems, including the lack of affordable housing, infrastructure, and growing disparities between the rich and the poor, than with gentrification.

Perceptions of waterfront revitalization, which had a more positive connotation than gentrification, were mixed. Participants stated that revitalization would translate into increased tax revenues, jobs, and opportunities. Unfortunately, this has not yet occurred. City revenues have increased by 47 percent, but the tax rate has increased 40 percent since 1984, and interview data suggests that job creation does not appear to benefit the residents. Thus far, the city has only experienced a physical alteration of the waterfront as it was converted from an industrial waterfront to a mixed-use complex largely devoted to housing, commercial, and retail space, as well as an onslaught of additional problems.

The externalities of revitalization—cited as displacement, higher taxes, and exclusion of some groups—were slightly more evident. Displacement is a highly contentious issue. Participants differed considerably as to the extent and impacts of displacement. City officials believed that approximately 8,000 to 10,000 residents were displaced by gentrification and that these persons left for other parts of the city, other cities, or left the state entirely. Records of displaced persons were kept by the city during 1986 and 1987 and while the results are circumspect, the number of displaced persons more than doubled between 1987 (496 displaced) and 1986 (217 displaced) (Office of Tenants Assistance Displacement Registry, 1986, 1987). Property taxes have also increased. Additional externalities include environmental quality concerns and the ever-present affordable housing squeeze.

City Policies

In response to campaign promises, the Cucci Administration created the Affordable Housing Linkage Program in 1985 and strengthened city housing ordinances. The Affordable Housing Linkage Program is a voluntary program that "links" market rate housing and commercial and office development to the subsidization of inner city affordable housing. Developers are encouraged to create affordable housing by building or rehabilitating units as part of their development projects, financing or sponsoring housing elsewhere in the city, or by contributing payments to a municipally established housing trust fund to be used by the Department of Housing and Economic Development (HED) to sponsor affordable housing throughout the city. Developers are urged to construct units, rather than make financial contributions.

Residential developers of all new or substantially rehabilitated housing developments must set aside 10 percent of all units for low and moderate income housing. Commercial and office developers must provide affordable housing based on a formula that estimates the likely impact of the project on the demand for housing in the city. The city also offers incentatives to developers, such as decreasing the affordable housing contributions or accelerating the permitting process, if certain conditions are met.

Since 1985, the municipal code has been revised to include multiple dwelling rent controls, unlawful harassment and eviction of tenants, anti-warehousing, and real estate canvassing. An ordinance was also passed prohibiting condominium conversions, which was overturned by the court.

Problems

While the linkage program is voluntary, developers wishing to build or renovate in the city must participate. It represents the "cost of doing business" in the city. HED negotiates with developers on a case-by-case basis. One major problem is that some phases and plans for developments were already underway before the linkage program was implemented and renegotiations with developers have been difficult.

Approximately 1,217 more units will be built as a result of developers' commitments to the linkage program. The success of the program is, however, debatable. While most of the city officials and administrators supported the linkage program, only 311 units have been built or will be built in the near future. In 1987, one developer provided 273 units of on-site middle- income rental housing. Ironically, the developer is having difficulties renting the units to families who fit into the stringent Federal moderate-income housing guidelines. In May 1988 ground was broken for 38 affordable homes as a result of an agreement between the city and another developer to provide off- site housing.

Members of the City Council generally believed that their efforts had improved the housing ordinance, although at least two councilpersons had reservations about the impacts of rent control. Two participants from the Citizen Participation Group suggested that the ordinances were too stringent and landlords found it difficult to meet expenses. Violations under housing laws are rather lenient—penalties usually consist of a fine of $500 and/or 90 day imprisonment. Also, newly constructed dwellings within a redevelopment area are exempt from these ordinances (all waterfront projects are in redevelopment areas). Neither the affordable housing linkage program or the stricter housing ordinances appears to have increased the amount of affordable housing in the city.

It was expected that gentrification was an important issue for the city as was indicated by much of the media during the mayoral election of 1984. By 1988, however, gentrification, while still a concern to some participants, in particular some city council members, was overshadowed by numerous other issues which include insufficient infrastructure, deteriorating environmental quality (due to the industrial nature of the city and congestion), inadequate transportation and concerns over increasing traffic, lack of affordable housing, and increasing taxes.

Conclusion

While the data demonstrates that, at least in the case of Jersey City, perceptions of gentrification are impacting policies related to the waterfront, the effectiveness of these policies in bringing about the desired results was not fully tested. Preliminary assessment shows that perceptions of waterfront revitalization are mixed, and revitalization has not necessarily created benefits originally anticipated. The public is not placated by the promises of the benefits of revitalization, while they attempt to deal with the lack of affordable housing, increasing taxes, and numerous other problems.

Evidence of negative perceptions was found in the interview data. Also, two plans of attack against gentrification—the affordable housing linkage program and stricter housing ordinances were evident. While the results of this research lend support to the hypothesis that decisions made by city officials and administrators were directly influenced by the public's negative perceptions of gentrification, and that these perceptions would be translated into policies and ordinances, it must be understood that gentrification appeared to be much more of an issue in 1984 and 1985. Currently, gentrification issues have been incorporated under the litany of affordable housing. This suggests that factors other than gentrification may have been responsible for altering waterfront revitalization policies, although this study did not address those factors.

Interested readers are referred to the entire thesis, located at the University of Rhode Island, Kingston, RI.

REFERENCES

Projected Waterfront Development. 1988. Internal Document. Urban Research & Design Division, Department of Housing and Economic Development, Jersey City, NJ.

Office of Tenants Assistance Displacement Registry. 1986, 1987. Office of Tenants Assistance, Department of Housing and Economic Development, Jersey City, NJ.

"Waterfront Update: Major Development Projects as of April 1988." Spring 1988. *On the Waterfront* 3. Prepared by the Govenor's Waterfront Development Office, Jersey City, NJ.

DEFINING MIXING ZONES FOR CSO'S: CAN THE CONCEPT BE APPLIED IN DEVELOPING REGULATIONS?

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INTRODUCTION

Many of the older municipalities in this country, especially those along the eastern seaboard, have sewer systems which combine sewer wastes with storm runoff. Unfortunately, many such systems cannot handle the combined flows during heavy rains, and the excess is often discharged into the nearest body of water. Such discharges, called Combined Sewer Overflows (CSO's), are a significant source of pollution in rivers and coastal areas.

By their nature, CSO's are point sources subject to the requirements of the Clean Waters Act. This pollution problem, however, has not been as tractable as that from regular wastewater treatment plants. The location of overflows, in the middle of the the most heavily urbanized areas, their sheer number, and their intermittent flow, make it difficult to develop inexpensive technological solutions. As a result, regulatory agencies have been slow in developing generalized effluent guidelines for CSO's. At present, the policy of the Environmental Protection Agency in the Northeast (Region 1) is to consider each CSO on a case by case basis (EPA, 1987).

Since the number of CSO's is one or two orders of magnitude larger than the number of sewer outfalls, trying to develop a control strategy based on a case by case analysis is monumental. Attempts have been made, and still are being made, to develop more generalized concepts and regulations. In Massachusetts one concept being considered by the state environmental agency, the Department of Environmental Quality Engineering—DEQE, is that of a "mixing zone". The mixing zone is defined as the area in the receiving waters in which excursions from water quality standards are to be allowed within certain limits (DWPC, 1988). This approach is being considered because it would reduce the need for very expensive technical solutions to the discharges by, de facto, lowering water quality standards in the immediate area of the discharge.

The use of this concept in developing regulations assumes that a method for estimating the size of the mixing zone exists, and that water quality standards will usually be met within a reasonable distance of the discharge point. It is assumed that adequate mixing will take place before important coastal resources are impacted.

Our analyses and modeling of CSO discharges from several municipalities in Massachusetts, however, indicate that the methods for estimating mixing zones are very complex. Furthermore, the basic assumption that water quality standards can be usually met within a reasonable distance of the discharge point may be inappropriate.

METHODS FOR ESTIMATING THE MIXING ZONE

The mixing zone for discharges from waste water treatment plants can be estimated by modeling the dilution taking place as the effluent plume is mixed with the receiving waters. With outfalls located offshore, and in deep water, two dimensional models are often sufficiently accurate to be used. The major factors that influence the behaviour and dilution of the effluent plume are the relative buoyancy of the discharge and the velocity of currents in the receiving waters.

In coastal waters however, two dimensional models do not have enough detail to completely predict dilution and transport. Factors such as the duration and volume of the flow, wind induced surface currents, tidal currents and eddies, the density difference between fresh and salt water, and the shape and depth of the receiving waters all interact to determine the size and shape of the discharge plume and its dilution. Furthermore, most models used today use a deterministic approach to model pollutant transport. Pollution from CSO's, however, is stochastic in nature and not easily characterized by a determistic models (Harremoes, 1988).

Some of these problems can be overcome by developing three dimensional models that incorporate most factors. Such models exist, but they are extremely complicated because they attempt to model stochastic events using a deterministic approach. Models, such as the one developed by Battelle Ocean Systems for New Bedford Harbor, are capable of estimating the dilution that occurs near shore from intermittent discharges. Such models, however, have one major disadvantage—their cost. Trying to adapt a three dimensional model for each CSO that needs to be controlled will quickly become prohibitive. For example, a simulation of the pollution transport in New Bedford Harbor over only four tidal cycles, using the Battelle model, costs approximately $10,000 (based on costs to Camp Dresser and McKee for use of the model).

Before trying to develop a three dimensional model for estimating mixing zones, or trying to combine several two-dimensional models, we would like to explore the idea that the concept of a "mixing zone" may be the wrong approach for regulating CSO discharges. Our concerns regarding mixing zones come from studies which indicate that plumes of polluted freshwater can travel large distances before enough mixing takes place to meet water quality criteria . The plume will almost always impact a beach, shellfish bed, or natural resource before it is adequately mixed. Thus, developing regulation based on the concept of a mixing zone will usually result in the conclusion that the discharge cannot be allowed because an important resource will be impacted.

Several different analyses have led us to this conclusion. The first is based on using a very simple model of dilution. The second is based on using two dimensional estuarine models, and the third is by using a density flow model. None of these methods accurately describe what really occurs when a CSO discharges because they model only a few of the many factors that influence plumes. They can be used, however, to outline the scope of the size of the mixing zone.

EXAMPLE USING CSO'S IN LYNN, MASSACHUSETTS

The models were used to estimate the size of the mixing zone for CSO's in Lynn, Massachussetts. Of the 6 major CSO's in Lynn, we looked at the discharges from three: two that discharge into Lynn Harbor and are combined in our calculations, and one that discharges into Nahant Bay (Figure 1). The flow characteristics and pollution loadings from these CSO's are summarized in Table 1. A more detailed characterization of the discharges can be found in Camp Dresser & McKee (1988). The marine resources that can be impacted from the CSO discharges are summarized in Figure 2.

TABLE 1:
Characteristics of CSO discharges into Lynn Harbor and Nahant Bay. Volumes are in millions of gallons (MG).

Location	Average Flow For 2-Week Storm	Average Flow For 5-Year Storm	Dilution Needed To Meet Water Quality Criteria For Bacteria	Dilution Needed To Meet Water Quality Critera For Copper
Nahant Bay	2.3 MG	42MG	4000:1	none
Lynn Harbor	0.6 MG	11.7 MG	300:1	20:1

Dilution model

For the CSO discharge into Lynn Harbor, a dilution of 300:1 is needed to meet water quality criteria for coliform bacteria and a dilution of 20:1 is needed to meet criteria for copper—the two pollutants needing the highest dilution. With a 2-week storm discharging 0.6 million gallons, and a 5-year storm discharging 11.7 million gallons through the two CSO's, volumes of 180 mg and 3510 MG respectively are needed to dilute the discharge to meet coliform standards. For copper discharges the volumes of the receiving waters needed are 12 MG and 234 MG for the two storm conditions respectively. For the discharge into Nahant Bay the dilution requirements are even greater. Although no toxic compounds are discharged here, a dilution of 4000:1 is needed to meet standards for coliform bacteria.

A first order estimate of the size of the mixing zone can be made by determining how large an area of the receiving waters is needed to provide the level of dilution described above assuming instantaneous mixing. In the example of Lynn Harbor, there are approximately 150 MG of water in the area extending to the edge of the dredged shipping channel, and 19,000 MG within Nahant Bay at low tide (Figure 2). These estimates were derived from the NOAA Chart (#13275).

By comparing the estimated size of the receiving waters with the dilutions needed to meet water quality criteria it can be concluded that neither the Harbor nor the Bay is large enough to adequately dilute the discharge from a 5-year storm, and Lynn Harbor is even too small to adequately dilute coliform bacteria during a two week storm. This estimate is crude since it does not take into account the duration of a storm nor the tidal flushing that takes place. It can be used, however, to provide a computationally simple first order approximation of the area that can be impacted by CSO discharges. The comparison of the potential mixing area with the resources in the area (compare Figures 1 and 2) shows that resources are impacted by the discharges, even if the estimate is wrong by a factor of two or more. Thus the mixing zones of the CSO's in Lynn Harbor and Nahant Bay as they are estimated from a "dilution" model will almost always include some critical resource.

Estuarine Flow Models

The Dynamic Estuarine Model (a model developed by Camp Dresser and

McKee) was used to predict the size of the mixing zone in Lynn Harbor while the Tidal Embayment Analysis/Eulerian Lagragian Analysis Model (TEA/ELA) developed by the Massachusetts Institute of Technology Parsons Laboratory was used in Nahant Bay. Both of these models incorporate tidal flows, the intermittent nature of the discharge in the modeling, and can address wind effects, albeit crudely. They do not, however, include the density differences between the discharge and the ambient water. The description of the models and their use is given in Camp Dresser & McKee (1988). Briefly, the models were calibrated with data collected in the field, and then the discharge from the 2 week and 5 year storms were modeled using average tidal conditions.

The results from these two models, summarized in Figure 3, show that by adding a time factor the dilution of the effluent is impproved relative to the simpler model described previously. The figure shows the dilutions 24 hours after an overflow began. The results from these models, however, still indicate that water quality criteria will not be met by the time the plume from a 5 year storm reaches critical resources. In Nahant Bay the plume reaches the beaches before a 4000:1 dilution is achieved. In the Harbor shellfish beds are subject to a plume that is diluted only by a factor of 100:1, not the 300:1 needed to meet the criteria.

These results again suggest that the mixing zone for CSO discharges can extend over large areas of coastal estuaries and bays. There is a high probability that critical resources will be impacted before the discharges are dilute enough to meet water quality criteria.

Density Flow Model (CORMIX1)

Since coastal CSO's discharge freshwater into salt water the density difference between the two may result in the formation of a lens of effluent that does not mix immediately with the receiving waters. Measurements of dispersion in actual plumes have shown that the density differences may significantly enlarge the mixing zone. In Jamaica Bay plumes of effluent were still measurable more than 1 mile from the discharge point (Cataldo, et al., 1987).

The two estuarine models used, DEM and TEA/ELA, do not take into account the stratification that may occur. This aspect of the mixing dynamics was investigated using CORMIX1, an expert system computer program for mixing zone analyses of waste discharges that is being developed (Jirka and Doneker, 1987; Doneker and Jirka, 1988). CORMIX1 predicts the dilution that can be achieved for submerged discharges having a different density than the receiving water. The model takes into account density differences between the discharge and the receiving water, the velocity of the discharge, and the local currents that can move the plume. It does not, however, model any wind induced mixing that may occur.

In order to use CORMIX1, which requires submerged discharges, we hypothesized that the CSO discharge in Nahant Bay was changed to an offshore location at a depth of 5 meters. When the conditions for a two-week storm were modeled, using the field measurements of ambient currents, temperature and salinity (Camp Dresser & McKee, 1988) the model indicated that the plume would extend over 2 km before a dilution of 100:1 is achieved. This again suggests that the discharge will not be mixed well enough to meet water quality criteria at the beaches.

CONCLUSIONS

The relatively small volume of receiving waters, the strong tidal currents, wind, and the density difference between discharged waters and the receiving waters are all factors that extend the size of the mixing zone. The results from the modelling and field measurements (Cataldo, et al., 1987) indicate that the discharge plume from a CSO along the shore can travel several kilometers before enough dilution occurs to meet water quality criteria.

In the example of three CSO discharges in Lynn all three modeling approaches indicated that the mixing of discharges will not be sufficient to prevent impacts on nearby resources. Since the other coastal communities in the Northeast such as Boston, New Bedford, Salem and Gloucester, all have CSO's discharging into shallow constricted bays, similar problems can be expected in these cities. The mixing zone of a discharge will almost always include some critical resource; thus, making it difficult to use this concept as a way for developing regulations.

The size of a mixing zone can be reduced by some form of treatment before discharge. Such an assumption was not made in this analysis because we were exploring the concept as a general approach to regulations. Treatment at the point of discharge becomes a very site specific problem because each effluent has different pollutant characteristics (see Table 1 as an example). Developing regulations based on a mixing zone, but which then require detailed site specific treatment does not achieve the original goal of a general approach.

If the concept of mixing zones is not readily applicable to CSO discharges, do other options for developing regulations exist? One idea being considered by regulators in Massachusetts is to limit the number of discharges (DWPC, 1988). The assumption is that every discharge from a CSO would cause a water quality violation and impact some resource. The impacts on the coastal environment would be reduced by limiting the discharges to four per year. The state would reserve the right to apply more stringent requirements if a critical resource is impacted. This approach makes technical control measures more feasible since there is no need to design systems to handle extreme storm conditions that occur infrequently. The unresolved question with this approach is whether four "pollution" events a year is an acceptable environmental compromise.

Another concept being considered is a definition of the mixing zone based on the physical properties of the discharge, rather than its dilution. The mixing zone would be defined as the area within which the buoyancy and momentum of the plume is dissipated ("momentum reduction method" Camp Dresser & McKee, 1988). The unresolved question is how to reconcile this definition with the need to meet the water quality standards mandated by law.

CSO regulations are still in their embryonic stage, and now is the time to explore different concepts. In this paper we have summarized our experiences in trying to apply the concept of the "mixing zone" to stimulate discussion of the issue. In the future we plan to explore other concepts in more detail, including the feasibility of using the "permitted violations" concept, and also we will try to develop empirical model for assessing size of CSO plumes in different coastal environments.

REFERENCES CITED

Camp Dresser & McKee, 1988. Lynn Water and Sewer Commision, Combined Sewer Overflow Facilties Plan—Phase I. Report on Screening Alternatives.

Cataldo, J.C., A.D. Ronan, M.L. Thatcher, and J. Ahmad. 1987. Modeling stratified flow in combined sewer overflow. *Journal of Hydraulic Engineering*, 113:207-224.

Doneker, R.L. and G.H. Jirka. 1988. CORMIX1: An expert system for mixing zone analysis of conventional and toxic single port aquatic discharges. U.S. EPA (in print).

DWPC (Massachusetts Division of Water Pollution Control) 1988. Draft 314 CMR 4.00 Massachusetts Surface Water Quality Standards.

EPA (U.S. Environmental Protection Agency). 1987. "EPA Region 1 policy statement concerning the relationship between the regulation of discharges from combined sewer overflows and water quality standards."

Harremoes, P. 1988. Stochastic models for estimation of extreme pollution from urban runoff. *Water Research* 22:1017-1026.

Jirka, G.H. and R.L. Doneker. 1987. Expert system for mixing zone analysis of toxic and conventional discharges. *Proc. Nat. Conf. on Hydro. Eng. ASCE*, Williamsburg, VA.

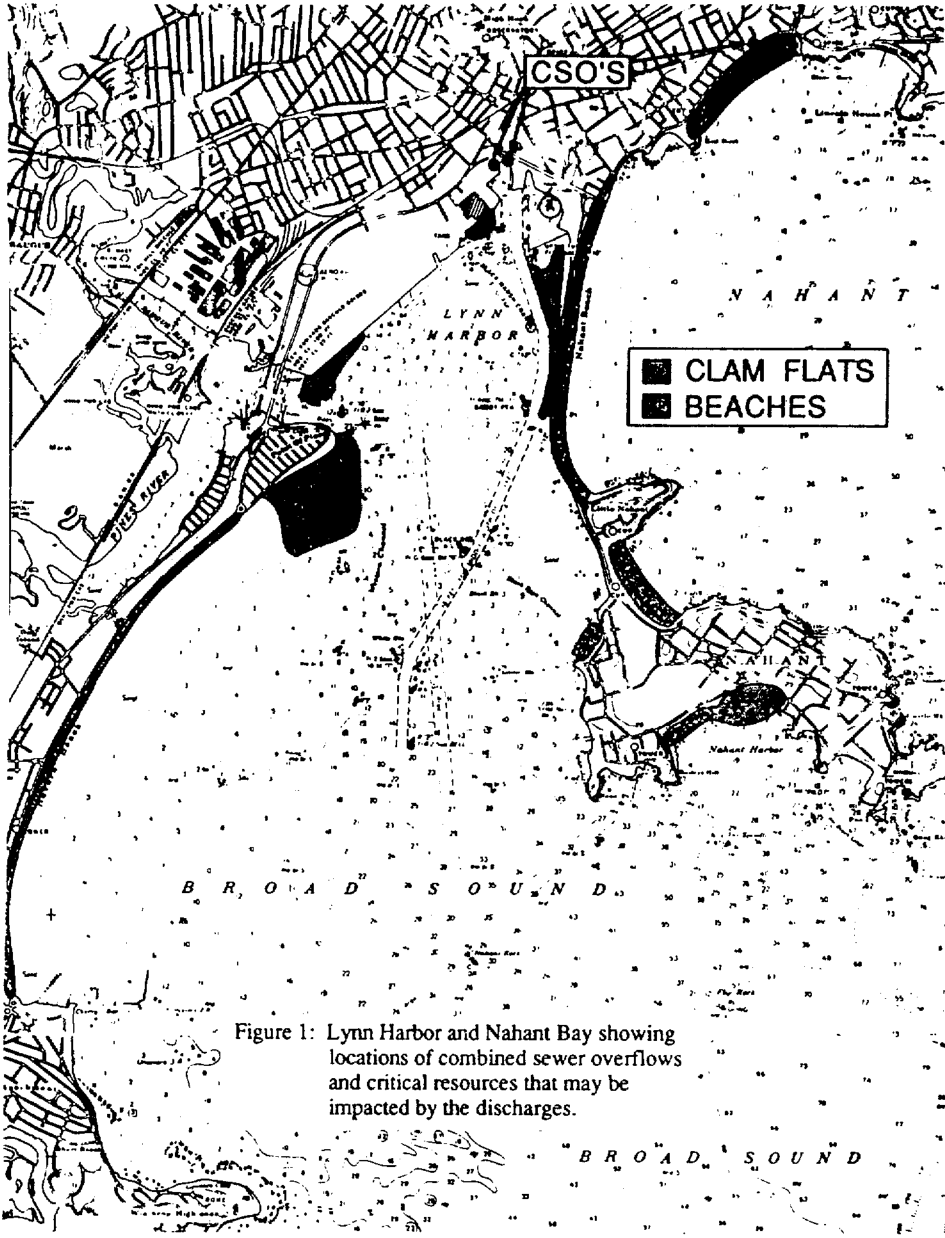

Figure 1: Lynn Harbor and Nahant Bay showing locations of combined sewer overflows and critical resources that may be impacted by the discharges.

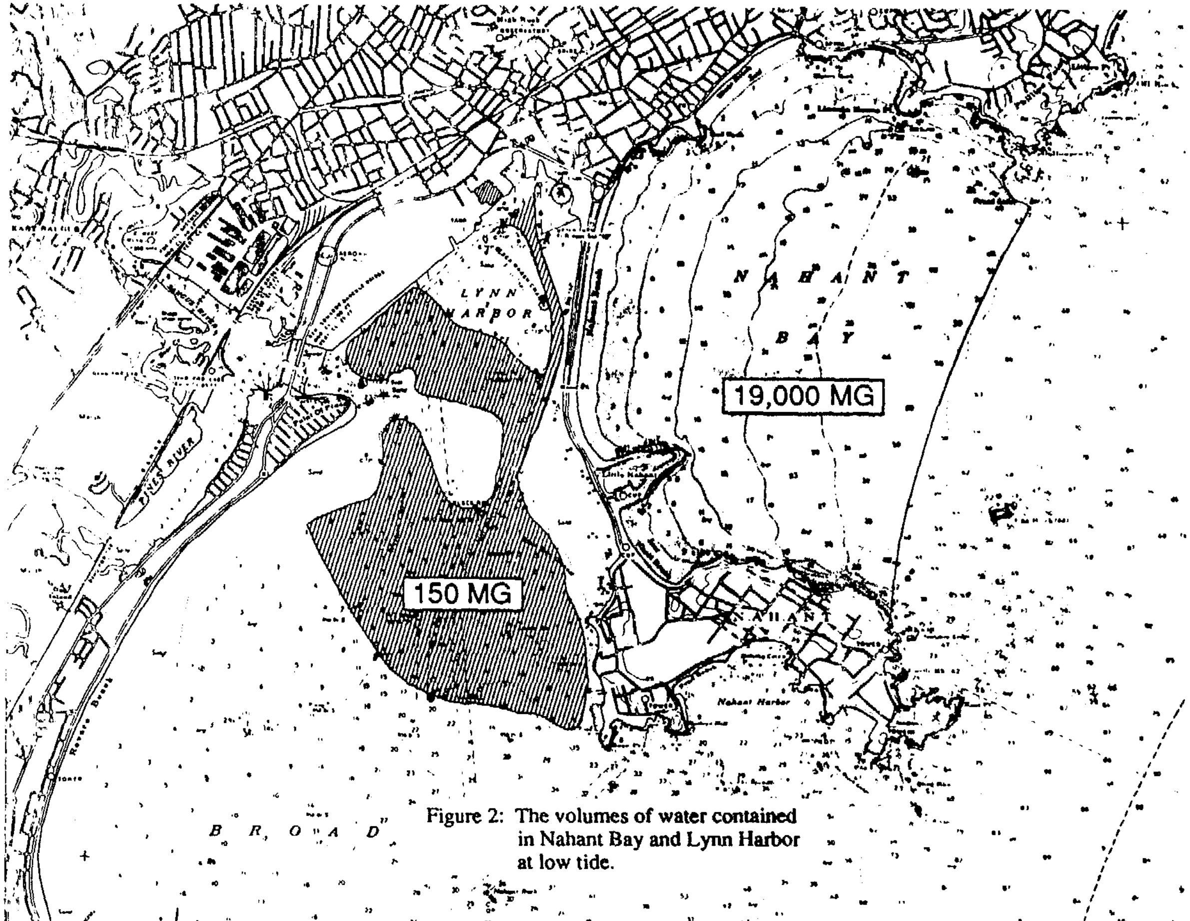

Figure 2: The volumes of water contained in Nahant Bay and Lynn Harbor at low tide.

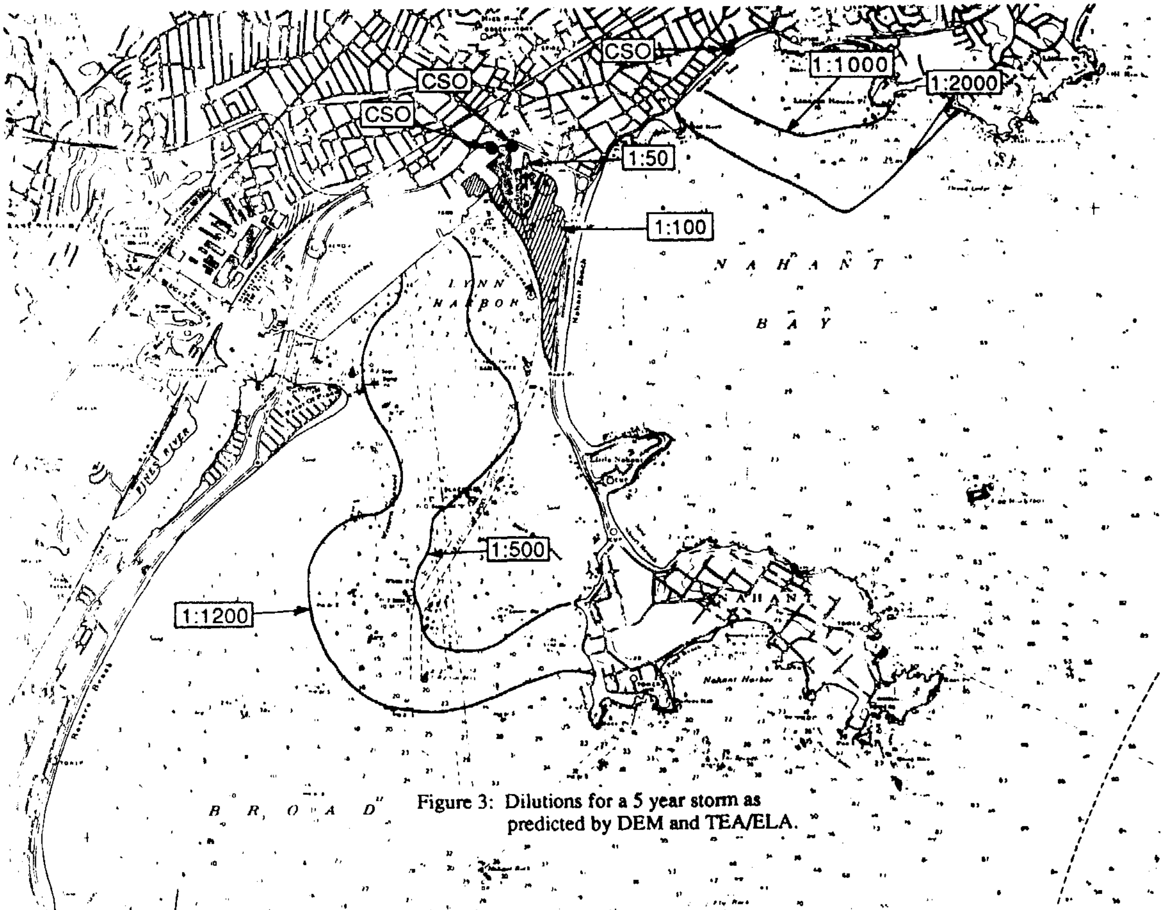

Figure 3: Dilutions for a 5 year storm as predicted by DEM and TEA/ELA.

So You Think You've Got Problems? The Massachusetts Dredging Project Facilitation Program

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Introduction

For some reason, dredging is complicated. It is complicated in its conception and early planning. There is no doubt complications will arise in the permitting of the project. Even the actual dredging is problematic, not just with regard to where to put the dredged material or how to get it there, but just removing the appropriate amount of sediment from the permitted location seems to be difficult even under the best of circumstances. The rationalizations for why this is outnumber the complications.

Given this premise, it should be perfectly understandable that a large percentage of dredging projects should, at some point in the process, get mired in that process. While some of these projects may deserve their fate, the majority involve work which is, to some degree, necessary for insuring safe passage for vessels using the harbor, and in a larger sense, maintaining the harbor's economic vitality. However, attempting to quantify an acceptable level of "safety", or determining the importance of a dredging project with regard to the harbor "economy" can be extremely difficult, even with that most elusive of bureaucratic commodities, policy guidance. This is particularly true when balancing this assessment of need against an estimate of the potential environmental damage to the harbor, or larger coastal ecosystem, that might occur as a result of the project. Underlying all of this "balancing" are the arguable assumptions that these assessments of need and environmental impact are reliable to some acceptable level of certainty, and undertaken without excessive bias.

This balancing act of regulatory decisionmaking, while quite complex, appears to distill into three basic elements: (1) the history of the regulator and the personal and agency predilection toward dredging projects generally; (2) the "weights" regulators place on various factors (e.g. economic, environmental, navigational safety, political, etc.) important to reaching a decision, and (3) the interplay of regulators which must issue permits, licenses and other authorizations for the project. While the substance of this analysis is Massachusetts' regulation of dredging projects, it is the dynamics of these relationships among regulators which provides the backdrop for this discussion, and may prove to be the more illuminating context.

The Massachusetts Regulatory Framework

While space will not allow a full and detailed discussion of the complexities of the environmental regulatory framework of the Commonwealth of Massachusetts, it is important to acquire some cursory understanding of the system in order to better appreciate its more byzantine aspects. For a more complete treatment of the topic, please consult Barr (1987) and O'Connell and Clarke (1987).

While the bulk of the environmental regulation in Massachusetts falls within the Massachusetts Executive Office of Environmental Affairs, both the Federal agencies, particularly the Corps of Engineers and the EPA, and the local governments play a significant role in the regulation of dredging projects. At the local level, the town "Conservation Commission" (comprised of volunteers appointed by the local board of selectmen, mayor or city council) acts, pursuant to the Wetlands Protection Act (Massachusetts General Law C.131, s.40), to regulate any activity which involves "dredging, filling, altering, or removing" in any wetland resource area. As such, dredging is clearly within the local jurisdiction. Local conservation commissions decisions, called "Orders of Conditions" are subject to appeal to the state Department of Environmental Quality Engineering (DEQE), Division of Wetlands and Waterways Regulation (DWWR). Many conservation commissions also regulate under their own local "wetlands" by-law or ordinance, which may differ somewhat in content and scope from town to town. Appeal of the local wetlands by-law is made to Superior Court of the Commonwealth Despite the fact that all conservation commissions act under the same basic law, local environmental regulation is somewhat inconsistent from town to town.

The State agencies represent the second tier in the framework. In addition to the DEQE/DWWR, whose Wetlands Section acts as the appellant body for local decisions under the Wetlands Protection Act (WPA), the DWWR also has a Waterways Regulation Program (WRP), which acts pursuant to MGL C. 91. Their jurisdiction is limited to those areas below Mean High Water and involves primarily the regulation of impacts to navigation and public access, although environmental considerations underlie many of regulatory decisions made thereunder. Another section of the DEQE which is important to the regulation of dredging is the Division of Water Pollution Control (DWPC), which issues Water Quality Certifications. Their jurisdiction extends to wetlands, although their primary activity is in areas below MHW, and deals with discharges of pollutants to waters of the Commonwealth. Dredging is one of their primary concerns.

If a dredging project involves the removal of sediment in excess of 10,000 CY, the proponent must file an Environmental Notification Form (ENF) with the Massachusetts Environmental Policy Act (MEPA) Unit. This process, similar to the National Environmental Policy Act in scope, is essentially an information clearinghouse for the regulatory agencies of EOEA. No permit, license, or other authorization may be issued by an EOEA regulatory agency until it has been determined, by the Secretary of Environmental Affairs through the MEPA Unit, that sufficient information has been submitted to adequately assess the potential for environmental impacts associate with the project. When it is used appropriately, it is the best tool that the Commonwealth has for coordination of its environmental regulatory activities.

The final action at the state level is the issuance of Federal Consistency by the Massachusetts Coastal Zone Management (MCZM) Office. This involves the formal determination that the information submitted to the federal permitting agencies is consistent with the Massachusetts Coastal Zone Management Program. No federal permit can be issued, nor any federal action commence unless and until Federal Consistency has been issued. As a practical matter, this process represents a way to insure that the permit conditions contained in the state and local permits and licenses and other authorizations are incorporated into the federal permits. As the primary nexus between the Commonwealth and Federal agencies with regard to environmental regulation, this process can sometimes become rather contentious, but is can also fruitful in providing opportunities to improve overall coordination and cooperation at this level.

The Federal regulatory structure is similar to that elsewhere in the country. The primary players are the New England Division of the U.S. Army Corps of Engineers, which is the primary permit issuing authority, The Environmental Protection Agency, acting in its role as benevolent advisor to the Corps with the power to veto, and the National Marine Fisheries Service and U.S. Fish and Wildlife Service, who are advisory and act with the EPA, at least in Massachusetts, as the Corps' environmental "conscience". The intra- and inter-agency dynamics at this level alone would be an interesting study.

While not directly related to the regulation of dredging projects, because the vast majority of dredging projects are funded by either the Corps of Engineers, Navigation Branch, or the Massachusetts Department of Environmental Management, Division of Waterways, as the principal "proponents" of most larger dredging projects, these agencies can also have some substantial impact into how effectively and efficiently the permitting process can proceed.

What should be clear from the foregoing discussion, without little more in the way of discussion, is that the opportunities for "process meltdown" are many. The pitfalls are both obvious and insidious, with changes in agency personnel and the passage of time producing changes not only the rules of the game but in the game itself. Despite all of this, the process works, after a fashion.

The Massachusetts CZM Dredging Program

The Massachusetts Coastal Zone Management Office has many responsibilities beyond its regulatory role as arbiter of Federal Consistency. The Office has a significant role in policy development and implementation with regard to coastal issues, and is also responsible for providing technical assistance to coastal communities. The MCZM Dredging Program was established to coordinate the activities of the Office where issues of dredging policy and planning arises, and to provides necessary technical assistance.

More than 90% of the dredging in waters of the Commonwealth is is paid for with public funds, and a good portion of that funding is state money. The other major funding source for dredging is, of course, the Army Corps of Engineers, although those monies have been dwindling recently in large part due to decreasing Federal allotments for such work. The third major funding source is the local communities themselves, who have been providing a greater percentage of late of the overall price tag through cost-sharing at the state and federal level. It is because of this increasing local role, which carries with it certain responsibilities involving permitting and design of projects that was one of the primary motivations for the establishment of the Dredging Program.

Technical assistance from the MCZM Dredging Program can take three basic forms, up-front education, project-related advise, and project facilitation. The "up-front education" has principally taken the form of the production of a comprehensive review regarding how to go about dredging in waters of the Commonwealth. This document, *The Dredging Handbook: a Primer for Dredging in the Coastal Zone of Massachusetts* (Barr 1987), discusses, in some detail, the types of dredges available and their attributes and limitations, the disposal of dredged material, and provides a thorough analysis of the regulatory framework that surrounds the dredging process. Testing requirements for dredged material are also discussed, and an extensive bibliography is provided. Once this document was completed, MCZM held a series of regional workshops to discuss dredging, in general, and the document, in particular. These workshops introduced federal, state, and local officials to the MCZM Dredging Program and the various services it could provide to them.

The "project-related advice" is, as would be expected, an ongoing activity of the Program. This usually involves meeting with agency representatives, usually municipal officials, one or more times to discuss any problems the project may have with regard to the design or permitting of the project. This interaction may also occur after the project has been permitted, to discuss how to deal with permit compliance issues or some other related problem.

The final type of technical assistance is project facilitation, where a project, for one reason or another, has run up against a problem which has brought the permitting process to a halt. This technical assistance most often involves identifying the problem(s), determining whether this problem is fatal to the project, and, if not, to provide a channel of communication between and among the principals to see if some accommodation can be reached. Without assuming any advocacy role, which is difficult in most instances, it is the primary task of the Program to coordinate, or mediate if possible, this attempt at compromise. It is this last type of technical assistance which is the subject of the following case histories.

Case Study: Sengekontacket Pond

Sengekontacket Pond is a relatively large and shallow coastal pond on the island of Martha's Vineyard. The pond has a navigation channel which runs between the two armored inlets. The project is maintained by the local municipality with cost- share funds provided by the Commonwealth. The last maintenance dredging proposal involved the dredging of approximately 40,000 CY of clean, medium to coarse sand. The dredged material was to be used as nourishment for a nearby state-owned beach. This project had received all of its necessary permits and other authorizations and was sent out to bid. When the bids were opened, the lowest was approximately double the original cost projection. Therefore the project had to be delayed while the project specifications were reexamined, and additional funds were secured by the Town to meet their share of the costs.

Because of these financial problems, the project had to be delayed for a number of months. This would not normally be a problem, except that the permits included seasonal dredging restrictions for both an anadromous fish run and for a threatened (federal and state-listed) shorebird species. Because of this delay, the project could not be completed until at least a month into the restriction. Both the local community and the state funding agency felt that waiting an additional year was inadvisable due to existing shoaling, and some concern that water exchange between the pond and Vineyard Sound was diminishing to the point where the shellfish populations were being adversely affected. It was at this point that MCZM, through the Dredging Program, became involved in facilitating the project.

After only a very cursory review, it became clear that the seasonal restriction was placed on the project without benefit of more than the most preliminary analysis of the need for such permit conditions. While it was true that the pond has an active anadromous fish run, the run goes through the southern inlet, and heads south to another adjacent pond, away from the proposed project site. In addition, because of the grain size of the material to be dredged, the amount of turbidity generated appeared to be insufficient to adversely affect the run, even during its peak periods. Given this information, the Massachusetts Division of Marine Fisheries (DMF) was able to provide a letter to the permitting agencies stating that the prohibition was unnecessary for this project. As to the shorebird restriction, upon closer investigation of the nesting records, the Massachusetts Natural Heritage and Endangered Species Program (NHESP) was able to determine that the site had not been used for at least three years. Further, they concluded that long term benefits of the nourishment project as habitat enhancement would be a good reason to move forward with the project before the next nesting season. They, like the DMF, provided a letter in support their reevaluation.

These letters from the resource agencies were instrumental in allowing the state permitting agencies to modify their permits and authorizations in a timely way. Armed with this information the final permit yet to be modified was the Section 404 permit from the Corps of Engineers. As it turned out, the Corps was far less willing to consider a modification to their permit than the state agencies had been, despite the recommendations of the DMF and NHESP. Citing the burdens of heavy workload and the complexity of the process to modify an issued permit, as well as the claim of a continuing objection of the U.S. Fish and Wildlife Service (despite the fact that the NHESP scientist who wrote the aforementioned letter is a member of the Federal Recovery Team for that species, and that similar flexibility to that requested was extended to a recent Corps dredging project), the Corps denied the request, and the permit stood as issued.

Case Study: Nantucket Federal Navigation Project

At the request of the Corps of Engineers Navigation Branch, MCZM was asked to provide early coordination regarding the maintenance of the Nantucket Federal Navigation Project. This channel is located at the entrance to Nantucket Harbor, and is important to the islanders as providing safe passage for the ferries which link it to the mainland. Like the Sengekontacket Project, the dredged material is comprised of clean, coarse sand.

The necessity for this early coordination was that, because state policy requires that this type of material be used for beach nourishment, and no such site seemed to be available, a conflict was sure to arise. During this meeting, our concerns were discussed, alternative nourishment sites were examined, and possible dredging scenarios were presented. We ultimately concurred with their assessment that the only disposal site available for this project was a "nearshore" site. The use of this site could both be accommodated by the hopper dredge which the Corps was proposing to use, and would keep the sand in the littoral system of the adjacent beach, thereby accomplishing the goals of the policy to the maximum degree practicable.

However, what began well quickly deteriorated. Because of an accommodation between the Corps and the Commonwealth, projects such as this require a "local sponsor" who is responsible for securing all necessary state licenses and permits, to which the Corps maintains it is not subject. After the Corps had issued is Public Notice for the project, it was discovered that the local sponsor had not initiated the state permitting process, which can, and usually does, take much longer than the federal action. While MCZM had been involved with the project since that early coordination meeting with the Corps, the project facilitation formally began when we contacted the the local sponsor and arranged to initiate the MEPA review for them and act as their representative until such time as the proper permit applications could be sent to them, completed, and returned (being two-hours by boat from the mainland has its disadvantages). Given that there was general agreement by the state regulatory agencies that the project was designed in accordance with all relevant state regulations, based the MCZM review in early coordination, the MEPA process was expedited and all state permits subsequently secured. Through flexibility and cooperation among regulators, the project was completed within the projected time schedule. No progress has been made on the project since that decision was made

Conclusion

The lessons learned from these case studies are as follows:

1. When agencies are burdened with excessive workloads, anything beyond routine processing of permits may not be gracefully received. Expect flexibility and level of cooperation to be inversely proportional to the number of permits in the backlog.
2. Permitting at the various levels of government does not occur on a "level playing field". In the case of the Segekontacket Pond project, it was clear that the state-funded (i.e. non-federal) project would not be afforded the same level of regulatory flexibility as a Federal project might be given.
3. Individuals and inter-agency "group dynamics" may be more significant to the decisionmaking process than the "best available information". It is likely that no amount of "facilitation" would have been sufficient to get the Sengekontacket project moving again.
4. Early coordination is essential to work out potential problems before the necessary permits applications have been submitted.

Environmental regulation and management are as much art as science. It may well be that "people skills" are more important to effective regulation of dredging projects than in-depth scientific or technical knowledge. It is the nature of the dredging process to demand more of those who involve themselves in it. Whether regulator, proponent, or dredging contractor, it is essential to communicate concerns effectively, provide as many opportunities as possible to allow the free exchange of information among the parties involved, and be willing to show some flexibility and accommodation.

References

Barr, Bradley W. 1980. *The Dredging Handbook: A Primer for Dredging in the Coastal Zone of Massachusetts*, Massachusetts Coastal Zone Management Publication, 181 pp.

O'Connell, James F., and John J. Clarke 1987. The Massachusetts CZM Project Review Process. Pp. 3961-3971 *in* O.T. Magoon, H. Converse, D. Miner, L.T. Tobin, D. Clark, and G. Domurat, eds., *Coastal Zone '87: Proceedings of the Fifth Symposium on Coastal and Ocean Management*, Seattle, Washington, May, 1987.

STABILIZING TIDAL BANKS WITH CORDGRASS, *SPARTINA* SPP.

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ABSTRACT

There are several thousand miles of actively eroding shorelines along the coast from Massachusetts to North Carolina. Low value lands lies behind most of this shoreline. These sites are the ones most likely to be stabilized with vegetation.

The shorelines in most harbors and ports are too severe for stabilization with vegetation alone. Two cordgrasses have been identified for stabilizing tidal streambanks. These can be planted in combination with engineering structures adjacent to ports and harbors. The grasses are *Spartina patens* saltmeadow cordgrass which grows above mean high tide elevation and smooth cordgrass *S. alterniflora* that grows within the intertidal zone.

A superior cultivar of saltmeadow cordgrass, 'Avalon' has been developed by the Soil Conservation Service and is commercially available. The Cape May Plant Materials Center is actively conducting evaluations with selected strains of smooth cordgrass to identify a superior strain for use with Avalon.

Wherever applicable, cordgrass offers a much lower cost alternative for stabilizing tidal lands than engineering structures. Cordgrass can also be used to stabilize deposits of hydraulic fill dredged from harbors and channels.

Site selection criteria, growth habit, planting technique, and maintenance procedures will be reviewed in the paper.

INTRODUCTION

Soil erosion is a natural process. In the absence of man's influence this is not necessarily destructive. However, our intensive use of the coastal zone has accelerated soil erosion to a critical level. More than 50% of the United States population lives within 100 miles of the coast. The need to support this population with industry, housing, food, and import-export trade has placed a strain on our natural resources. With more free time, the demand for expanded recreational activities adds to the problem.

This erosion is partly due to storm action, freezing and thawing and waves eroding the shoreline during high tide periods. The increased use of the waterways by commercial, fishing and recreational crafts have accelerated the rate of erosion.

The objectives of the presentation are to (1) explain beach characteristics that often affect establishment of vegetation on tidal shorelines, and (2) review establishment and maintenance procedures for using cordgrass on tidal banks.

PROBLEM

Erosion of coastal sounds, tidal streambanks, and ocean beaches is a major problem along the Atlantic coast. The rate of erosion varies from zero on protected sites to as much as 10 feet annually on harsh open beaches. The result is eroding shorelines, polluted fish habitat, clogged navigation channels, and the formation of tidal flats or the enlargement of existing ones.

Of course, when sand is eroded at one location, it must eventually be deposited elsewhere. This material may develop a nearby tidal flat, clog the navigation channel or be moved a distance of several miles by littoral drift.

The theme of this meeting is 'Ports and Harbors': our link to the water. This theme clearly addresses the issue of keeping our ports and watercraft channels open. Periodic dredging and disposal of the soil becomes a gigantic problem.

There are three major causes of tidal shoreline erosion. One is normal wave action which may cause shoreline erosion. During storms the water surface will be elevated above normal. This elevated surface may touch unprotected shorelines causing extensive erosion.

The third cause is wakes or waves generated by water craft. In fact, boat wakes are a major cause of tidal bank erosion in and near ports, piers, and other landing areas. Even water craft well offshore generate high energy waves that may pound the shore. These waves break on shore gently losing energy on protected sites but eroding unstable shorelines.

SOLUTION

One solution is to develop a fringe of tidal vegetation along the shore. This is accomplished by establishing plants adapted to a saline environment. The desired result is the formation of a tidal marsh. The two grasses previously referred to are saltmeadow cordgrass *Spartina patens* and smooth cordgrass *S. alterniflora*. Let us review the two grasses in their natural habitat.

Saltmeadow cordgrass normally grows above high tide (MHT) elevation. 'Avalon' is a superior cultivar and should be planted wherever saltmeadow cordgrass is recommended. This perennial grass can withstand occasional inundation by saline water and protects the toe of the slope at the base of the streambank. It grows in the zone where sand may accumulate, thereby, raising the elevation of the beach. This elevated surface can provide additional protection against normal wave action.

Smooth cordgrass seldom grows above the MHT elevation but can grow as low as mean low tide (MLT). This species breaks up the incoming waves and protects the beach from scouring waves. These plants are taller than those of saltmeadow cordgrass. The leaves are more coarse. The foliage and stems of smooth cordgrass decompose more rapidly than that of saltmeadow, partially because the plant material is submerged on a daily basis.

Shoreline erosion occurs as the waves strike the toe of the slope (Figure 1). The wave action undercuts the bank resulting in a unsupported wall of soil, usually very sandy. This unstable mass of soil sloughs off and the undercutting process begins again. The general bank profile may be rather steep and 2 to 25 feet high. Vegetation will not solve all tidal bank erosion. Engineering structures are clearly necessary on high energy sites. However, tidal vegetation does have an important role in stabilizing tidal shorelines.

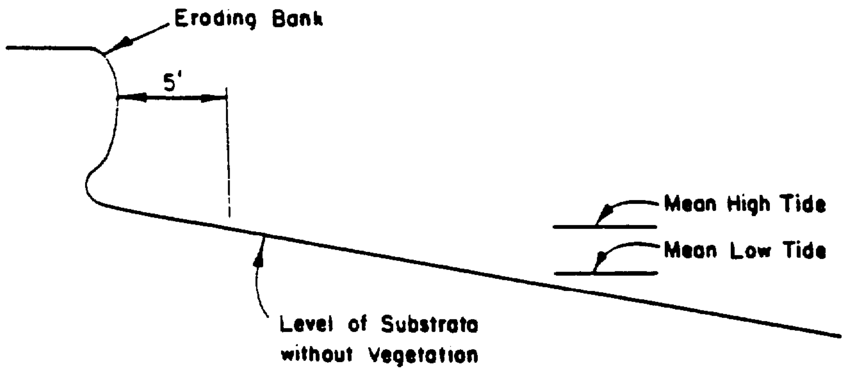

Figure 1. Typical eroding tidal shoreline.

SITE SELECTION CRITERIA

Soil Conservation Service personnel and others interested in tidal bank erosion identified this problem as early as the 1950's and SCS has been seeking solutions since the 1970's. Site selection criteria were developed by SCS Plant Material Specialists and the U.S. Army Corps of Engineers' staff. These criteria make use of several beach characteristics to predict "vegetation treatment potential". The use of these data does not guarantee success but does limit the failure rate by selecting sites where the potential for the establishment of vegetation cover is good. They are...

1) Fetch
2) General shape of shoreline
3) Shoreline orientation
4) Boat traffic
5) Width of beach
6) Width of planting area
7) On shore gradient
8) Beach vegetation and
9) Depth of sand.

A field guide has been developed to make use of these criteria. The guide permits the evaluation for potential vegetative success on a given site prior to actual planting.

Now let us look at how these characteristics can affect the vegetative success of a particular site:

1) Fetch: The distance of open water in front of the proposed planting. This distance is measured 45 degrees to either side of the shoreline. Distances up to 1.5 miles have little effect on vegetative treatment success. Open water with a fetch distance of 3.5 to 5 miles is severe while distances greater than 5 miles may limit planting success.

2) General Shape of Shoreline: Shorelines may be classified as coves, irregular and straight. The shoreline includes the proposed site and 200 yards on either side of the site. Coves offer the best protection while headlands and straight shores are severe sites.

3) Shoreline Orientation: This is the direction the shoreline faces. The most desirable direction is west to north while east to south or north is the most harsh. This characteristic factors in potential storm damage.

4) Boat Traffic: The absence of boat traffic is desirable but unlikely for most sites. More than 10 events per week within 100 yards of shore is severe. Groins and other engineering structures can partially abate this limitation.

5) Width of Beach: This is the area between MHT and the toe of the slope. Distances greater than 10 feet are desirable while a width less than 7 feet might limit planting success.

6) Width of Planting Area: Do not plant the site if the width is less than 10 feet.

7) On Shore Gradient: This is the slope of the planting area. Slopes less than 8 percent are desirable while slopes greater than 15 percent may limit success.

8) Beach Vegetation: The absence of beach vegetation indicates a harsh site. The presence of native tidal vegetation indicates a good likelihood of success.

9) Depth of Sand: A sandy beach is desirable. This is a good planting medium and indicates a source of sand to build the beach elevation. A clay site does not necessarily mean the plants will not survive, but the absence of sand indicates a sand starved beach. Without a source of sand, the plants cannot trap material to elevate the beach surface.

PLANTING TECHNIQUE

There is a sequence to planting the two cordgrasses (Figure 2). On sites with tidal fluctuations greater than 2.5 feet, plant smooth cordgrass from MHT to mean tide (MT) elevation. Where the tidal fluctuation is less than 2.5 feet, plant the smooth cordgrass to MLT elevation. Avalon is planted above the MHT elevation.

In some instances, plant 'Cape' American beachgrass at the base of the slope. At least 10 feet of planting area must be available to insure success. The desired

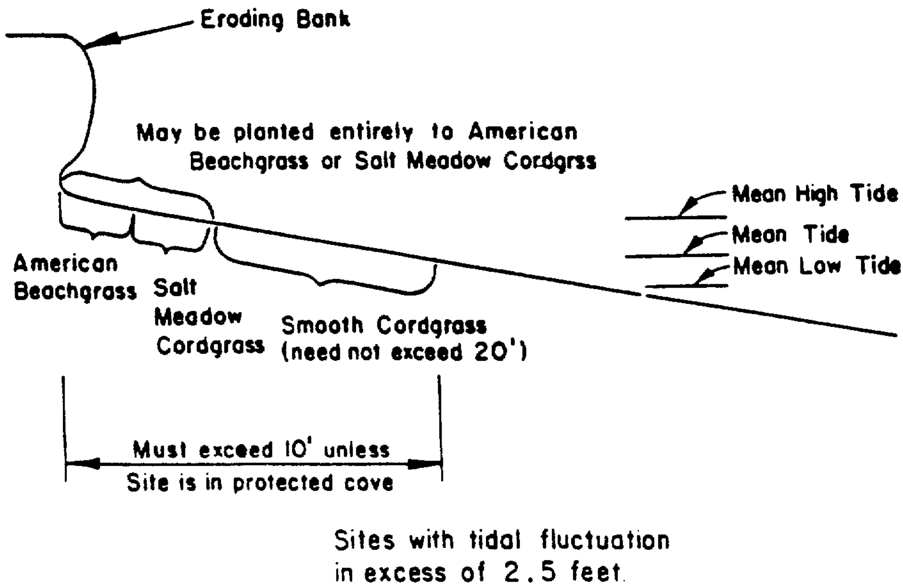

Figure 2. Recommended planting arrangement when tidal fluctuations exceed 2.5 feet.

result of planting is to elevate the surface of the beach to prevent waves from touching the toe of the slope (Figure 3). The previously eroding bank is now protected at MHT. One to three rows of Cape planted at the base of the slope will help trap sloughing soil and enhance beach stabilization. Normally, the beachgrass will be planted 45 to 90 days before the cordgrasses. To prepare a site for planting, it may be desirable to shape the vertical bank to reduce the slope. In some locations this is not possible due to cost, site inaccessibility, or restrictions on the adjacent bank area. Any debris, whether dead plant material or solid matter, should be removed. Debris may cause eddies and channelization of water. The minimum width of beach for planting is 10 feet. This distance is measured from the toe of the slope to approximately MSL.

Also plant four to six parallel rows of Avalon above the MHT elevation. Three to six rows of smooth cordgrass can be planted below and parallel to the saltmeadow rows. A minimum of three rows of each cordgrass should be planted. Planting width in excess of 20 feet is usually not justified. The cordgrass rows can be spaced 2 to 3 feet apart depending on the severity of the site. Spacing between plants should not exceed 18 inches on steeper sloped beaches. The plants in adjacent rows should be staggered to give an effective plant spacing equal to one-half of the actual distance between plants. Potted plants are recommended for all cordgrass tidal plantings. Smooth cordgrass plants grown in fresh water must be properly "hardened" before out-planting. This can be accomplished by subjecting the plants to increasing levels of saline solution over several days.

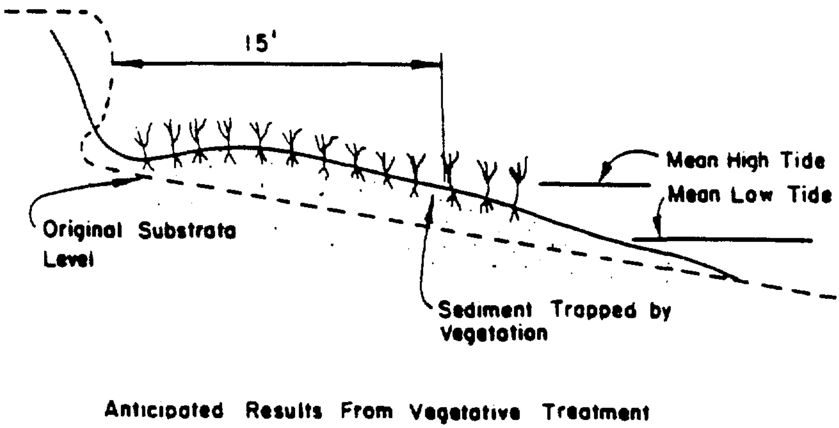

Figure 3. Potential role of vegetation in tidal shoreline stabilitation.

A slow release fertilizer placed in the planting hole will enhance immediate regrowth and provide nutrients through part of the growing season. Severe wave action may destroy a new planting within 3 days. The use of mechanical devices can be beneficial in reducing onshore energy. Temporary sand (snow) fence is one mechanical structure that can serve effectively as a breakwater.

The beginning of a successful planting is a low energy site, vigorous plants, proper planting technique and favorable weather conditions. Favorable weather conditions are defined as the absence of severe storms. Vegetation can stabilize some eroding tidal banks and beaches. Under normal conditions one can expect complete vegetative cover in the second year. However, during winter the vegetative cover becomes dormant and may even deteriorate. Yet, the elevated beach and extensive root system help protect the shoreline during plant dormancy. But the site becomes alive again in the spring. New growth will stabilize the beach against normal erosion. Once bank erosion ceases, the bank will assume a stable slope and non-tidal plants will invade.

SUMMARY

Two cordgrasses, smooth and saltmeadow have been identified as important native plant materials for vegetating tidal shorelines. The 'vegetative treatment potential' data can be used to determine feasibility before planting any site. The use of vigorously growing young potted plants is recommended for all plantable sites. Maintenance is important to the longevity of vegetation. The scoured areas should be replanted, fertilizer should be applied annually, and debris removed after each storm.

REFERENCES

Belcher, C.R., and D.W. Hamer,Sr. 1987. "Cordgrass Holds up Bank". Soil and Water Conservation News 8 (6).

Hamer, D.W., C.R. Belcher and R.W. Duell. 1988. "Registration of 'Avalon' Saltmeadow Cordgrass". Crop Science 28:193.

USDA-Soil Conservation Service, 1980. "Vegetation for Tidal Shorelines Stabilization in the mid-Atlantic States". Broomall, PA.

HARBOUR MANAGEMENT: Shore Issues, Environmental Quality and Coastal Planning

PORT & HARBORS: OUR LINK TO THE WATER

COMPETITION ON THE WATERFRONT: DISPLACEMENT OF TRADITIONAL MARITIME USES

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> *A tug, set neatly in between two barges, each loaded with twin rows of box cars, backed out into the stream and quartered slowly, steadily, with its enormous freight, then started head-on up the blunt snouts of the barges, as the little tug between them neatly forged ahead with its great cargo, with a sense of limitless power, and with astonishing speed...... The excitement, the beauty, the feelings of wonder and recognition which all of the associations of the scene evoked, were intoxicating.*
>
> Thomas Wolfe
> No More Rivers

The shallow draft vessels, towboats and barges, provide a wide range of essential services to the coastal ports and inland waterways of the nation. The American Waterways Operators, the national trade association for the shallowdraft industry, estimates that there are 1,800 companies which operate over 4,000 tow boats and tugs, and which move 24,000 dry cargo barges and 4,000 tank barges. The industry serves 87 percent of the major U.S. Cities, employs over 180,000 people and generates revenues of approximately $1.5 billion a year.

The enormous contribution the shallow draft industry makes to the economic vitality of the nation can best be appreciated by reviewing the products which are transported and efficiency of the transportation network. Farm products, petroleum products and distillates, construction aggregates and equipment and waste materials are all transported over the waterways. The cost to transport these products and materials via an integrated waterway network is substantially less than transportation by rail or truck. A single barge can transport a commodity that would take 15 railroad cars or 60 trucks. In addition, barge transportation is 2 1/2 times more energy efficient than railway transport. In essence, the towing and barge industry is by far the most efficient and least costly of all the transportation modes with respect to transporting and distributing bulk cargo.

The Port of New York & New Jersey, traditionally considered the nation's premier port, encompasses more than seven hundred miles of waterfront property. The port complex, located seventeen miles from the open sea, is well protected from storms or other extreme weather conditions.

The Towboat & Harbor Carriers Association of New York and New Jersey is the local trade association representing those companies engaged in the towing and barge industry. The Association, founded in 1970, was formed by the consolidation of the New York Boat Exchange (1917) and the Harbor Carriers of the Port of New York (1934). The Association promotes the common interests of the members by representation on a number of Federal, State and local maritime advisory committees. The majority of members are family run companies with a rich heritage and presence in the Port.

The equipment owned and operated by member companies includes tugs, barges, motor tankers and passenger vessels. These companies are the major transporters of petroleum products, scrap metal, sand, gravel, waste material and construction equipment. The fleet of vessels consists of 200 tugs, 300 dry cargo barges, 150 tank barges and 15 coastal tankers. On a daily basis, tug and barge transits within the port constitute better than seventy-five (75) percent of all vessel movements in the harbor. Consequently, the services provided by the industry are an integral part of both the regional economy and the vitality of the Port's waterways.

> *Commerce has the first claim on the New York waterfront, but no one will dispute some of it should be saved for the pleasure and refreshment of the people.*
>
> New York Sun
> October, 1853

Traditionally, although the water's edge was the hub of activity, the waterfront was regarded as a noisy and undesirable locale to which only the most adventurous would travel. The presence of industrial facilities, ships, warehouses and freight yards were better left out of the sight of the landed gentry. The advent of containerization rendered a number of shoreline structures obsolete. As facilities were abandoned, many waterfront areas fell into a state of disrepair which would only worsen with the impact of tide and time. For at least a decade, much of this waterfront area remained dormant. As maritime activity decreased, the waterfront became an underutilized and unproductive area subject of neglect.

Today the water's edge is the focus of a renewed interest on the part of residents and developers as plans for revitalization are designed and implemented. To a large extent, development plans come as a refreshing change. A great resource will no longer lay fallow. However, the extent to which the maritime community and development projects can be accommodated along the thin strip of land which defines the water's edge will clearly influence the future of maritime activity within the Port.

Shoreside development can exert enormous pressure on maritime facilities in terms of property values, expansion possibilities or ultimately relocation. Although the majority of projects envision a "mixed-use" development, "mixed-use" usually refers to commercial, residential and recreational uses. Little attention is paid to the "water dependent use" which by definition must be located on the waterfront. The marine transfer station, petroleum import and distribution center, sand and gravel facility, ship repair and supply yard are an integral part of the maritime industry. Without such facilities, essential services such as sludge transportation, channel maintenance, construction and waterfront clean-up projects cannot be provided. Additionally, vessels require locations where fresh water, ship repair and docking facilities are available.

In the recent past, the implementation of "mixed-use" development projects has directly led to the displacement of two tugboat companies, one ship yard and several marine support services. In the future, given the scope of projects currently under consideration, several more water dependent facilities may have to either relocate or go out of business. The question posed is where do these companies relocate to? Waterfront property is now at a premium. The companies normally operate on a thin margin of profit in a particularly competitive environmental. Substantial capital investment in a new facility may be all but impossible, not to mention the tortuous regulatory process to construct an industrial commercial installation.

Although a number of planners maintain that the traditional maritime uses of the waterfront can co-exist with residential development, reality dictates otherwise. To a large extent, maritime facilities are inappropriate areas for public access given equipment, safety and security concerns. In addition, the owner of residential complexes often object, "after the fact" to the presence of maritime facilities in close proximity to housing. A "first in time" argument is usually not persuasive and considerable pressure is brought to bear on the maritime facility.

Maritime groups in the Port of New York & New Jersey have alerted both regulatory agencies and legislative bodies to the impending problem faced by the industry. Although the Coastal Zone Management Programs of both States outline a preference for water dependent uses, legislative solutions or amendments to State law have not been enacted. The result is that additional economic and operational pressures are placed on an already marginal industry. Consequently, although waterfront development in large metropolitan areas is applauded as the revitalization of the water's edge, it may also represent the sword of Damocles for the maritime industry.

The legislative protection recommended by industry representatives focuses on amendments to State law which would preclude lawsuits against water dependent uses on the grounds that they constitute a "nuisance". Similar legislative protection has been provided for the farming industry on an State and local level. Most recently, Suffolk County has passed legislation which recognizes a "right to fish". The development potential and escalating property values on the East End of Long Island had "inspired" a number of project proponents to allege that traditional fish landing and processing facilities were not compatible with residential development. In this case, the local county legislature responded quickly to preserve the very industry which had made the East End a unique location in the first place.

The legislative remedy recognizes that traditional preexisting uses of the waterfront may warrant protection from the pressure exerted by development projects. No less a measure of protection is needed for the tug and barge industry in the Port of New York & New Jersey. The threat of displacement, forced condemnation or relocation of traditional maritime facilities will result in an uninteresting, unproductive and underutilized waterway resource.

> *But look! here come more crowds, pacing straight for the after, and seeming bound for a dive. Strange! Nothing will content them but the extremist limit of the land; loitering under the shady lee of yonder warehouses will not surface. No. They must get as nigh the water as they possibly can without falling in.*
>
> Herman Melville
> Moby Dick

Waterfront development projects usually incorporate plans for a marina, recreational facilities and public access. Although these particular aspects of development are widely regarded as beneficial, they may pose some serious operational issues for the maritime industry.

The proposals for marina development come at a point in time when such facilities in the New York and New Jersey area are sorely lacking. The projects envision docking space for anywhere from one hundred to six hundred recreational vessels. The proposals are designed to compliment upland development such that residents of the condominium complex can have access to the marina and in some cases actually own the docking space. In this situation, waterfront development is not only influencing the escalation of property values, but also utilization and ownership of the waterway.

Marina development along commercial waterways poses a problem with regard to the efficient use of the waterway. Tugboats and barges must operate at optimal speed in order to safely navigate the waterway. Commercial vessels operating at optimal speed may create a wake in transit. Unless marinas are designed to attenuate the wake of passing vessels, the recreational vessel operators will not know if their interests have been adequately protected.

In addition to the design of a marina, the location, density and type of vessels at a marina is of concern to the commercial mariner. A number of accidents involving commercial vessels and recreational boats have resulted in damage to property as well as the loss of lives. U. S. Coast Guard inquiries into the circumstances surrounding the accident usually reveal that the recreational boat owner was unaware of the commercial vessel, underestimated speed or maneuverability and/or could not be contacted via marine radio. The mixture of commercial and recreational vessels, one on a jaunt and the other doing business can be fatal. As the number of recreational boaters increase, the possibility of accidents may become a probability.

The source of the problems appears to be a general lack of experience and information concerning safe boat handling. Recreational boat owners are not necessarily educated with regard to navigational rules of the road and the appropriate courtesy and safety measures applicable to a waterway. The problems posed can be addressed by requiring a course in the safe operation of a vessel and developing safety plans for large scale marinas. Several states are currently considering legislative proposals which require a license to operate a recreational vessel. Familiarity with local waterways, navigation charts, and the ability to contact a recreational vessel via marine radio would certainly help to avert potential problems.

Safety plans have been proposed by the U. S. Army Corps of Engineers in the Philadelphia District which outline the circumstances under which a recreational vessel must defer to a commercial vessel. The plans were developed in response to several proposals for large scale marinas to be located along commercial waterways. The specifics include a traffic management scheme, restrictions on entering and leaving the marina complex, navigation and safety lights or beacons and an education program for the recreational mariner.

The recommendations concerning protective structures and safety plans for marina as well as education courses for the recreational mariner are currently under review by several State legislatures. The appropriateness of such measures should be evaluated with regard to providing the highest measure of protection for both the recreational and commercial mariner and the greatest degree of latitude to insure the continued utility of the waterways.

An' I loves the ships more every day, Though I never was one to roam.
Oh! The ships is comfortin' sights to see, An'they means a lot when they
says to me- "Always somebody goin' away, Somebody gettin home."

John Joy Bell
On The Quay

In summary, Federal, State and local regulatory agencies must be mindful of the problems posed by the renewed interest in the waterfront. The maritime industry makes too important a contribution to the residents of a city, and in fact a region, to be disregarded. The thin strip of land along the water's edge is a precious resource, both fragile and dynamic. Deteriorated shoreline structures, inaccessible waterfront areas, or underutilized maritime facilities are neither aesthetically pleasing nor economically sound. The economic dynamics of the maritime industry and its continued viability is critically linked to the well being of the people in coastal areas. The preservation, development and enhancement of waterway resources in a thoughtful manner will serve the goals of all.

Planning for Diverse Harbor Uses: Trends Toward Interagency Task Forces and Agreements

Geraldine Knatz, Ph.D.
Port of Long Beach

The title of my presentation is "Planning for Diverse Harbor Uses: Trends Toward Interagency Task Forces and Agreements. For the purposes of this presentation, I have taken the liberty of retitling my presentation to "From Shotgun Wedding ... to Prenuptial Agreement" - a phrase which I believe summarizes the trends that I see occurring in interagency planning.

But, before we get into the current state of interagency planning for ports and harbor, I think we need to talk a bit about the types of diverse uses that ports and harbors are planning for. Clearly, the title of this presentation supposes that planning for "diverse uses" is currently going on. And in fact it is. But if I were to survey the audience here today to find out what "diverse uses in ports" really means, I would receive many different opinions.

To a port planner, planning for diverse uses may be defined narrowly in terms of cargo uses such as terminals for different types of commodities. To someone else in the audience "diverse uses" may mean the port also provides for small boat marinas, water oriented recreational or commercial development, areas to preserve fish and habitat resources, waste handling facilities, and even waterfront residential areas. Today, the question of "diversity versus specialization" is a critical issue that is facing many ports.

Ports, like many institutions are currently having a "love affair" with the strategic planning process, using it as means to define their mission. A formal mission statement has been prepared by many ports to answer questions such as "who do we serve?" In many cases, the response to this question has been broadened well beyond the shipping community to include other competing uses for that scarce waterfront land. Those uses may include commercial waterfront development that is not water dependent but which benefits the surrounding community by stimulating economic growth and creating jobs.

What then is responsible for dictating the balance of land and water uses in ports? First and foremost are the legislative mandates the port is operating under. Depending on the "enabling acts" that established a port or the "tidelands trust grants", certain uses may be mandated. The tidelands trust grant for the port I work for, Long Beach, specificies navigation, commerce, fisheries and recreation.

Various state legislation often specifies allowable uses for specific geographic areas of the coastline. This same thing hold true for ports. For example, ports under the jurisdiction of the California Coastal Commission must prepare master plans which designate land and water uses. Any changes in allowed uses including elimination or displacement of any uses must be approved by the state Coastal Commission. Usually, the Commission requires those uses be relocated rather than eliminated.

On the local scale, the major balancing force is the port commission, an elected or appointed board of community leaders and business people which serve as a decision making body. It is not infrequent that the port staff, schooled and oriented toward traditional maritime functions often clash with the port commission which may be representing the broader interests of the community.

But the struggle faced by many ports is -to what degree should they balance the demands for diversity or should they stick with the tried and true cargo handling facilties?

Probably the best example of this is the current controversy at the Port of Oakland. Those of you that follow the trade newspapers may have followed the dilemna faced by Oakland as they try to determine if they should maintain their traditional transportation focus or devote their energies to non-maritime real estate development.

The Oakland Port Commission has argued that several hundred acres of port land should be developed to provide more jobs and economic benefits to the community. The port executive director argues that such a move would undercut the port's primary mandate which is commerce. Faced with this dilemma, the Port of Oakland finally adopted a tried and true strategy many of us have used in these situations- they hired a consultant to analyze and mediate the controversy.

This clash of ideas is by no means unique. It is also happening nationwide as America rediscovers its waterfronts and as competing uses jockey for scarce waterfront land. Dealing with this new reality requires innovation and a willingness to expand the land use planning process to include new participants. Land use planning for ports is more and more becoming an interagency process.

I really do believe that the "shotgun wedding" analogy is an appropriate one. Ports do alot of things because they are forced to. A good example is in the field of environmental mitigation. Years ago many ports, when faced with the requirement to "mitigate" for the adverse impacts of their developments on fish and wildlife would argue that their developments were in the national interest, were necessary for local job and commerce, implying that they were somehow "above" the requirement for receiving end of these arguments.

It quickly became evident however, that if a port wanted a dredging and landfilling permit, they had to mitigate for the project impacts. Ports found themselves carrying out fish and wildlife enhancement projects because they were forced to.

Well, today ports are still "forced to" but many have recognized that rather than waiting until the conflicts with resource agencies have escalated to such a point that their projects are seriously delayed, that mitigation proposals be included as part of the project development phases. This is where the "pre- nuptial agreement" comes in- upon conception of a development project, the first thing out of port environmentalist's mouth today is "where and how are we going to mitigate? This attitude shift has been a long time coming and those of us who were working in an environmental office of a port ten years ago recognize that changes that have taken place. (This, of course, assumes that the port had an environmental office ten years ago or even now!)

The fact that this change in attitude has permeated the port industry is illustrated by the publication of a mitigation handbook by the American Association of Port Authorities. This is not to say that ports are born-again "bird and bunny lovers" but most now recognize their environmental responsibilities.

But today, interagency planning with port authorities covers alot more areas that fish and wildlife mitigation. I would like to focus on three areas where interagency planning is making some major strides and those areas are:

1) traditional port planning;
2) transportation planning;
3) environmental planning.

I am going to discuss these three areas by describing only one project but a project that is large enough to require extensive interagency coordination at all levels and because this project illustrates a number of different types of interagency coordinating mechanisms. This project is known as Project 2020 and it is a project that is jointly begin developed by the Port of Long Beach, Port of Los Angeles and the U.S. Army Corps.

For those of you that are not familiar with San Pedro Bay, California, the Port of Long Beach occupies the eastern side of the Bay and the Port of Los Angeles occupies the western side of the Bay. Sandwiched in between the two Ports is the U.S. Naval Station which is within the boundaries of the Port of Long Beach. From a planners perspective, these two ports are part of the same harbor system.

Project 2020 is a plan to expand and create 2400 acres of new land in San Pedro Bay for port expansion in three phases between now and the year 2020. The construction of a portion of phase 1 was initiated in September 1988 and will create 147 acres of new land in the Port of Long Beach and dredge the main channel in the Port from 60 to 76 feet deep, in some areas as much as 90 feet deep. Now a project of this magnitude has enormous environmental impacts and impacts on the surrounding communities. Obviously coordinating with agencies is a major feat. For those of you that do not know the Ports of Long Beach and Los Angeles also are competitors. Yet we have recognized the need to coordinate planning for the Bay.

We are using multiple ways of orchestrating our coordination with the agencies that need to be involved. This one project involves a number of different techniques or tools:

Interagency mou's;
Escrow agreements;
Interagency task forces;
Interagency planning committee's;
Joint power's authority; and
Joint grant applications.

Depending on the issues to be dealt with by each group, and the need for funding the group, we have selected the appropriate structure to carry out the group's efforts. Let me tell you how we have used these different tools to aid in the planning process for this one specific project.

Let's start first with Memorandums of Understanding (MOU's). We use MOU's to establish a mechanism for cost-sharing or to commit people and resources to carrying out specific tasks within specific time frames. For example, there is a MOU between the Corps, and the two Ports which adopts a Plan of Study for the 2020 Plan federal feasibility study and the necessary joint federal-state environmental documents. Another MOU exists between the two Ports. This MOU allows the 2020 project managers from each port to contract for planning studies and split the costs. One thing we realized years ago is that even though we are competitors, we can save a lot of money by sharing consulting costs.

Another area where MOU's have been very effective is in the area of air quality planning. Obviously the air quality impact of project of this magnitude is enormous in an air basin which is the worse in the nation. It is not possible to differentiate the aire quality between Long Beach and Los Angeles so we try and tackle air quality problems together.

One strategy for reducing air pollutant emissions which is being looked at is "cold-ironing" or switching vessels to shoreside power when at berth. The feasibility of this is in question and some basic research is being undertaken and funded by several agencies. A MOU between the Western Oil and Gas Association, the South Coast Air Quality Management District and the Port of Long Beach and Port of Los Angeles established a mechanism where these parties can participate in funding the study.

For highway planning, we are using several other tools, specifically escrow accounts and the creation of a new administrative entity, a joint powers authority. Numerous rail and highway projects will be required for Project 2020. This begs the big question? Who is going to pay for all these improvements? The answer is a composite of federal, state, local government, port funds and fees paid by the user. Federal funds and local matching funds, where required, are administered by an interagency committee through use of an escrow account. The committee includes the ports, railroads, cities and transportation agencies.

To deal with the transportation impacts of Project 2020 in the long range involves development of a new consolidated transportation corridor. Freight traffic from the three rail lines that service San Pedro Bay will be consolidated on one line that runs through a mostly industrialized area as versus individual branch rail lines that use primarily residential neighborhoods. Contiguous to the rail corridor will be a truck expressway which will be developed by upgrading and widening an underutilized arterial.

For several years, an interagency task force consisting of 7 cities, three railroads, the transportation agencies in California and the Ports have worked on this program. Now as we move toward implementing the project, we are proposing development of a joint power's authority (JPA). This JPA will have the ability to secure bonds for capital construction based on the projected revenue stream from fees paid by users of the rail corridor.

A number of planning committee and task forces have also been created. If you remember, the Naval Station was sandwiched between the two Ports. A Ad-Hoc Port-Navy Planning Committee was established to provide a forum for airing and resolving Navy concerns. This committee recently expanded to the Ports-Armed Forces Committee with representation by the Coast Guard and Army.

As I mentioned to you earlier, Project 2020 envisions about 2400 acres of new landfill. In January 1988, an interagency biomitigation task force was created to develop and implement a biological mitigation plan for the first phase 2020 Project landfills. The task force includes federal and state resource agencies and the Ports-their mission is to find mitigation for the 2020 Project landfills. We have already obtained 600 acres of wetland restoration as mitigation but another 800 acres of mitigation are still required.

Now any of you that are familiar with Southern California, know there isn't a whole lot of suitable land available where we can create wetlands. If fact, restorable wetland areas are so scarce and so valuable that the Ports and private developers are competing with each other to lock up the remaining mitigations sites. This causes some concern among local cities and developers who are afraid that the ports, because we have the financial capability to fund restoration projects may gobble up all the development potential in the Southern California coastal zone.

The bottom line is we have to come up with different types of mitigation besides wetland creation, the most obvious being artificial reefs. Right now mitigation credits for artificial reefs are not yet allowable for Southern California Ports. Some basic research is still required. To provide funding for such research, the Port of Long Beach applied for and received funding under the Saltonstall-Kennedy program from the National Marine Fisheries Service in the amount of $132,000. The biomitigation task force will oversee this research.

I think I will conclude with a few comments about grants. Nothing works better to promote interagency planning that to have a source of funding, particularly when it comes from someplace other than the agencies involved in the planning. That way you don't have to squabble over who has to throw money into the pot but can concentrate on the real issues. I think many ports are not taking advantage of the opportunity to apply for grants for planning and research activities. In the last year, the Port of Long Beach has received over $350,000 in state and federal funds for planning studies. Most of this funding is administered by interagency committees. Our experience is that grant applications that are submitted jointly by a group of agencies are very well received. We have also teamed with local universities to assist them in obtaining grant funds to be designated for a planning issue that we need resolved. For example, the California State University received $200,000 grant funding from the surface transportation act of 1987 which will be used to help implement our consolidated transportation corridor.

So in summary, there are a number of coordinating mechanisms that can be used to facilitate interagency planning. We know that it is a must if you want to move your projects foward. But if you are still attending shotgun weddings, you are missing the advantages of interagency planning.

EILAT: MULTIPLE CONFLICTS IN AN INHERENTLY UNCERTAIN ENVIRONMENT

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With the growing attractiveness of waterfront for various activities, ports are often at the center of conflicts regarding the use and management of coastal areas. Demand forecasts, and information regarding natural resources and the interaction between various activities and resources are usually seen as prerequisites for rational coastal management. Port development prospects have therefore important implications for urban coastal management. Yet, there is often considerable uncertainty regarding ports' futures. In some cases it may be impossible to forecast future development patterns of a port. That is, possible scenarios for the port's development cannot be fully identified, or their probabilities cannot be estimated. Such inherent uncertainty may hamper the ability to make major decisions regarding the port, and complicates the management of coastal areas affected by the port. This paper looks at how the need to make a major decision regarding the Port of Eilat, in a situation of inherent uncertainty, is being approached and analyzed in Israel.

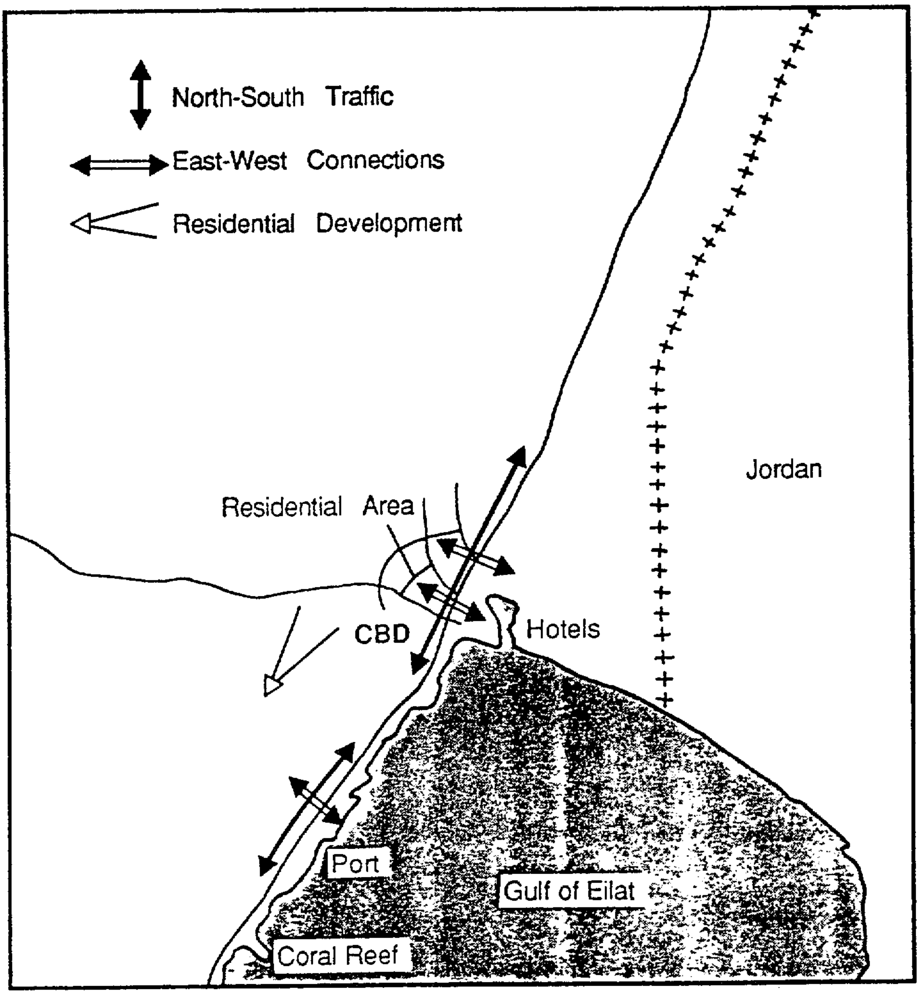
After a short description of the development of Eilat's port and the conflicts surrounding it, alternative courses of action are outlined. The evaluation of these alternatives is confounded by several uncertainties. In the third section we proceed to identify systematically the sources of uncertainty regarding the port and its relationship with its environment. The evaluation approach proposed in Israel is described in the fourth section. Finally, we discuss the implications of the Eilat experience for urban coastal management under uncertainty.

The Development and Problems of Eilat's Port

Eilat is Israel's only outlet to the Red Sea and the Indian Ocean. The port however was opened only in 1956 following the Sinai Campaign, as until then shipping lanes to it were blocked by Egypt at the Straits of Tiran. The present port, south of the city, was inaugurated in 1965. During the 60s and early 70s the demand for Eilat's port services was primarily a function of the economic relationships between Israel and the countries in Eilat's foreland, Asia, Australia and East Africa (Reichman, 1968; Gabrial, 1980). Following the closing of the suez Canal in 1967 a land bridge connecting the Eilat and the Mediterranean Sea was established, and an oil pipeline to Ashkelon on the Mediterranean coast was built (Gradus,1977). Lately, the reopening of the Suez Canal to international and Israeli shipping, and the fall of the Shah in Iran, reduced the demand for Eilat's services.

The port of Eilat is currently at the center of a number of local conflicts (Feitelson, 1984):

- It threatens Israel's only coral reef;
- It is a barrier between the main resort area (which is the city's primary economic base) and the coral reef;
- The transportation corridor leading to the port severs the city from the resort area, creating serious safety problems;
- It occupies a large and central part of Israel's 11 km Red Sea waterfront.
- It prevents direct access to the sea from the prime residential development areas.

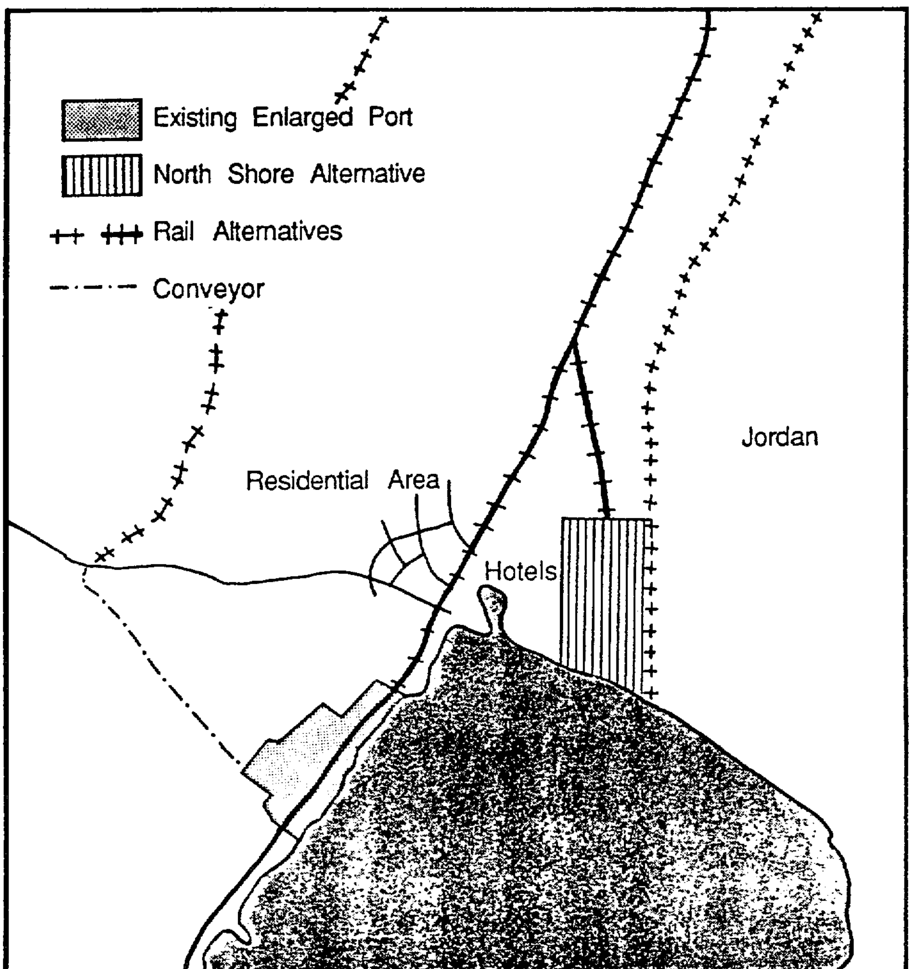


Map 1: Eilat Port and its Environs

The present landuse structure also encumbers the competitiveness of the port as it circumscribes the ability to connect the port by rail to the north, and hinders the movement of freights from the wharfs to storage areas.

The Alternatives

In recent years these issues came to fore in discussions regarding the national port masterplan, the local physical masterplan, and the future national coal supply plan. Two basic alternatives were suggested (Feitelson, 1984):



Map 2: Alternatives of Eilat's Port

1. To allow for expansion of the port in its present location, as a function of future demand. This would require one of two solutions to the rail access problem. Either the railway be constructed along the shore, aggravating the urban problems, or it bypass the city, requiring a conveyor connection to the port because of the topography west of the port. This alternative would not address all the aforementioned problems.

2. To transfer the port to an alternative location. A channel port was proposed in a regional plan in the mid-seventies. The prohibitive cost of the site suggested at the time, 11Km inland, precluded any serious discussion of this alternative. Recently the Ministry of Transportation suggested a site on the northern shore of the gulf, near the Jordanian border (Map 2).

[Map 2 about here]

Preliminary studies found the site proposed by the Ministry of Transportation is feasible from an engineering perspective, and at a reasonable cost. In evaluating the two alternatives planners had to address a number of uncertainties.

The Sources of Uncertainty

The uncertainties encountered by Eilat Port planners are in three spheres: Uncertainties regarding the demand for port services, uncertainties regarding the real cost of improvements in the port, and uncertainties regarding the effects of the port.

Uncertainties regarding the demand for port services

There are two primary factors affecting the demand for the port's services: economic and political.

The economic factors can be divided into three: 1) Demand for imports in the hinterland. This demand is a function of future economic growth in Israel, specific needs for commodities imported from Eilat's foreland, and future substitutions between such commodities and locally produced commodities or commodities imported from Europe or America. While all of these variables can be forecasted, the reliability and validity of such forecasts are doubtful beyond a very limited number of years. 2) The conditions in the world shipping market. These conditions affect total transportation costs, and consequently the amounts of goods transported. Longterm forecasts of such changes are notoriously uncertain. 3) Demand for Israeli exports in Eilat's foreland. This demand is a function of economic developments in the various countries in Eilat's foreland, the supply conditions in Israel, and prices of competing suppliers. Forecasts of all these variables beyond five years are highly doubtful.

In the previous section we have seen that the demand for Eilat's services was greatly affected by political events in the Middle East. Essentially two politically determined factors affect Eilat's future. One, the cost structure and possibility of transporting goods through the Suez Canal. Two, the access to various markets in Asia and Africa. As both factors are determined unilaterally by foreign, mostly undemocratic, governments, they are practically unforecastable.

Uncertainties regarding the cost of an alternative port

Most large scale projects are faced in their early stages with uncertainty regarding their cost. Much of this uncertainty is reduced as site surveys are conducted and detailed plans drawn. In the Eilat case there were four different estimates as to the cost of an alternative port on the north shore. A more troublesome uncertainty pertains to the opportunity costs of the projects. Theoretically the opportunity cost should be handled by using a social discount rate. Yet, despite much discussion and debate, there is no agreement as to how this discount rate should be determined (Lind, 1982).

Uncertainties regarding the effects of the port

Three important possible impacts of the port involve substantial uncertainty. The first are the possible impacts of the port on the coral reef, which is one of Eilat's main tourist attractions. The coral reef is sensitive to repeated oil spills (Loya, 1975), and to changes in water clarity and quality (Johannes, 1983). At present however neither the magnitude of the port's effects on water quality and clarity, or the extent of the reef's sensitivity to such disturbances are known. Additionally, the emissions of pollutants from the port is also unknown at present as it would be a function of still undetermined technologies that will be used in the alternative ports in the future. The second involves the impacts of the port on tourism. While the present port is clearly seen from the resort area, the north shore alternative can be shielded and thus will be less prominent visually, yet it will be much closer to the hotels. It is unclear what elements of the port have adverse impacts on tourism, and what are the magnitudes of such impacts. The third impact regards the safety hazards stemming from the port, as it handles both chemicals and explosives.

The Evaluation

After the preliminary studies showed the north shore alternative is feasible the Minister of Transportation set up two committees to evaluate the two alternatives. The first committee was charged with the economic evaluation and the second with the environmental evaluation.

The economic evaluation was concerned with estimating the cost of the north shore alternative, including rail construction, in comparison to the cost of expanding the existing port, including a road and rail by-pass to the city. This evaluation had to contend with the aforementioned uncertainties regarding the demand for port services and the cost of an alternative north shore port.

The approach of the economic evaluation for addressing these uncertainties was to conduct sensitivity analyses. The cost and benefits of the two alternatives were computed for twenty one scenarios, varying by the assumptions regarding costs, interest rates, land values and future demand levels and composition. These analyses indicate that for most scenarios the transfer of the port to the north shore is desirable. The only scenarios where this is not the case combine low demand levels, low land values (which indicate low demand by tourism), and high interest rates. Such circumstances could be seen essentially as delaying the transfer rather than negating it. More sensitivity analyses, varying costs for various sea routes, are currently being considered.

The environmental evaluation, compared the two alternatives in terms of their impacts on natural resources, tourism, and environmental quality for tourists and residents, their emissions, the potential damages of accidents and the ability to control and mitigate spills. The uncertainties encountered in this evaluation pertained primarily to the potential impacts of the port. To reduce some of these uncertainties a number of studies and surveys are suggested regarding the effects of bulk commodity handling on corals, and the currents in the northwest part of the Gulf of Eilat. In addition the potential effects of spills and the ability to control and mitigate the effects of malfunctions and accidents were compared. For most of these criteria the north shore alternative seems more suitable, primarily because of its greater distance to the Coral Reef.

Dealing with Uncertainty - the Lessons of Eilat

The economic and environmental evaluations of the alternatives for Eilat's port had to contend with three types of uncertainty. The first type stems from the lack of information or data regarding present conditions or interactions between various activities and resources. This type of uncertainty can be addressed by studies and surveys.

The second type of uncertainty pertains to possibilistic future effects. If the probability distribution functions of the various possible occurrences are known, this type of uncertainty can be addressed through a variety of evaluation and planning techniques. If the probability distribution functions are presently unknown, as is the case in Eilat, either additional studies are required to estimate the probabilities or the evaluation approach has to be robust. That is, the outcome has to be insensitive to changes in the probability of occurrence. In Eilat the maximum damages were assessed and the cost of mitigating or preventing such damages estimated for the two alternatives. Both criteria are insensitive to the probabilities of the damages.

The third type of uncertainty regards forecasts for whom probability distribution functions cannot be estimated. Furthermore, even the possible scenarios may not be entirely clear. This type of uncertainty, termed inherent uncertainty, poses the greatest difficulties for coastal management. As wide perturbation of the forecasted variables can be expected, any evaluation has to be very robust. That is the outcome has to withstand wide fluctuations in the variables on which it is based. In Eilat sensitivity analyses defined an envelope of possible cost benefit ratios showing the north shore alternative to be preferable under a wide range of combinations.

The ways the three types of uncertainty were manifested in Eilat, and the ways they were addressed are summarized in Table 1.

Table 1: Uncertainties in Siting Eilat's Port

Type of Uncertainty	Method of Addressing Uncertainty
1. Lack of Information	
1.1 Impact of coal on corals;	Research proposed;
1.2 Currents in the Gulf of Eilat;	Measurements and modelling;
1.3 Emissions from the port;	Sensitivity analysis for different technologies;

1.4 Construction costs;	Sensitivity analyses;
2. Probabilistic	
2.1 Effects of accidents;	Evaluation of possible damages, and ability to control and mitigate effects at both sites;
2.2 Effects of malfunctions;	
3. Inherent	Sensitivity analyses for various trade volume, cost and interest rate combinations;
3.1 Demand for exports imports through Eilat;	
3.2 Tariffs of Suez Canal and access to Israeli shipping;	
3.3 Access to markets in SE Asia and E. Africa;	
3.4 World shipping market situation (prices);	
3.5 Future interest rates;	

Table 1 reveals two general approaches to dealing with uncertainty. The first is reducing it through the acquisition of additional information. This approach is pertinent only for the first two types of uncertainty. Yet, in some cases the cost of information acquisition may be very high. The second approach is to use robust evaluation methods, that is methods whose results would be insensitive to uncertainty. This approach was extensively used in Eilat, through sensitivity analyses and evaluation of 'worst case' scenarios.

As coasts are an inter-related system of activities, and ports are often a central element in such systems, decisions regarding a port have wide ramifications for coastal management. In Eilat the location and activities of the port are the most important element for both planning the city and managing the coast. If uncertainty prevents decisions being reached regarding the port, it reflects on all other parts of the system. Thus no major decisions regarding the future development of the coast can be reached in Eilat before the port question is decided. This paper demonstrates that even in an extreme case such as Eilat uncertainty does not have to be resolved for decisions to be reached. Once a decision regarding the port is reached the uncertainty limiting the management of the rest of the coastal and urban systems is reduced.

References

Feitelson E., 1984, The Development of The Port of Eilat in Relation to its Urban Setting, *Horizons: Studies in Geography* 11- 12, pp. 178-187 (Hebrew).

Gabrial N.K., 1980, The Position of Eilat Port in the Trade Between Israel and the Countries of Asia and Africa, M.A. Thesis Department of Geography, The Hebrew University of Jerusalem (Hebrew).

Gradus Y.,1977, Is The Israeli Negev a Viable Alternative to the Suez Canal?, *Geoforum* 8, pp.29-32.

Johannes R.E., 1983, Coral Reefs, in: Clark J.R. *Coastal Ecosystem Management*, Robert E. Krueger Publishing, Fl, pp. 593- 5.

Lind R.C. (ed), 1982, *Discounting for Time and Risk in Energy Policy*, The Johns Hopkins Univ. Press, Baltimore.

Loya Y., 1975, Possible Effects of Water Pollution on the Community Structure of

Red Sea Corals, *Marine Biology* 29, pp. 177-185.
Reichman S., 1968, Commodity Movement in Eilat Port, *Studies in the Geography of Israel* 6, pp. 95-115 (Hebrew).

Group D.2 Harbor Use Conflicts and Coastal Education/Training Programs

"Educating Decision Makers About Coastal Development Trends, Impacts and Alternatives"

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Public officials and community leaders in coastal municipalities need to keep informed about: 1) Coastal land use patterns and the economic trends, public policies and regulations that affect them; 2) the impacts of these land use patterns upon society; 3) the impacts upon marine and land based natural resources; and 4) how other coastal communities have addressed these issues.

Many community leaders are volunteers or public officials who have little familiarity with the management of coastal resources. Educational programs can play a significant role in helping these key decision makers to utilize available information when making local decisions regarding coastal development. In many cases, informal educational programs are the most practical and effective way of providing this information. These programs, which encompass a wide range of formats and techniques, provide objective information while allowing participants to take an active role in the educational process through interaction with each other.

Major coastal development issues and related informal educational programs implemented in Connecticut reviewed are relevant to other states. Educational programs covered issues like: preservation of water-dependent uses, including commercial fishing dockage; harbor management, public access to the waterfront; and coastal habitat restoration. Educational techniques are described and addressed regarding format and target audiences. Based on these assessments, recommendations and guidelines are provided which can assist in the development of informal educational programs directed toward community leaders, public officials and interested residents in coastal communities.

Coastal Development Trends and Issues

A surge in coastal development during the past ten years has significantly altered coastal land use patterns in Connecticut and other northeastern states. Development pressures are creating coastal land use conflicts which were largely unheard of in the 1950s and 1960s. Since the late 1970s and especially during the northeastern United States' economic boom of 1983-87, a combination of factors has contributed to an increase in demand for coastal land and urban waterfront sites, continuing redevelopment of previously occupied areas, and new development in suburban and rural coastal areas.

The new coastal development trends are influenced by numerous factors. One factor is the rediscovery of the urban waterfront by developers, municipal officials, historic preservationists, and the millions of people who began to appreciate the attractiveness of living, working and recreating along the coast. Another factor is the 1981 Federal Tax Reform Act which reduced tax bills for the business sector and high income individuals resulting in billions of dollars of capital available for investment in waterfront properties. The 1983-87 economic boom (in the northeast) combined with the above factors to create an "explosion" in demand for coastal lands in Connecticut and other northeastern temstates. Demographic trends point to continuing above average rates of population and economic growth in many United States coastal counties.

Pressures on coastal lands are likely to continue since many Americans are migrating to the coast. It has been estimated that by the year 2000, 80 percent of the total U. S. population will live within one hour of the coastline.[1]

The surge in coastal development during the 1980s has resulted in numerous changes in use patterns of waterfront and near shore areas. One trend has been the displacement of water-dependent coastal uses of the waterfront by water-enhanced uses. Commercial fishing docks, marinas and boatyards have been replaced by condominiums, office buildings, and retail complexes which can produce higher profits for the owners of these water front sites and a larger tax base for the municipality. Other trends include loss or restriction of public access to marine waters (Long Island Sound, rivers and coves) and the waterfront, as well as a loss of water views due to new construction in the coastal zone.

Decisions being made regarding coastal land use patterns will in fluence society's use of these areas for several generations. Therefore, it is important for public officials, community leaders and the general public to be informed about coastal land use patterns, and the economic and social factors, public policies and regulations that affect them. The impacts of current and projected land use patterns upon society and the impacts upon marine and land based natural resources need to be examined. Information about how other coastal communities have addressed similar issues should be exchanged.

Marine Extension and Public Policy Education

Coastal development educational programs organized by the Connecticut Sea Grant Marine Advisory Program (SGMAP) utilize Extension education techniques with an emphasis upon a public policy education process. Marine Extension education involves informal educational programs designed to increase the knowledge base, improve skills and change attitudes of specific target audiences like commercial and recreational fishermen, public officials, marine firm managers or educators. It involves use of non-classroom methods such as conferences and workshops, field tours, use of mass media, developing publications and individual advising.

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[1]T. Maginnis. "Coastal Development Trends," NCRI News, Newport, OR: National Coastal Resources Research and Development Institute, Vol. 3, No. 2. September 1988.

Marine Extension techniques provide flexible approaches to assisting municipal public officials, coastal resource user groups and the general public in improving their understanding of coastal development trends, impacts upon both natural resources and society, and alternative public policies designed to achieve specific resource conservation, management and utilization goals.

Informal educational programs can be designed to:

1) Increase the knowledge base of target audiences regarding specific coastal and marine resource issues.
2) Improve the technical and decision-making skills of audiences.
3) Assist in changing attitudes toward conserving, managing and utilizing resources.
4) Relay research-based information from the scientific community to resource users and managers.
5) Identify marine resource problems and issues which can be addressed by researchers.

Public policy education involves educating the general public about decisions to be made by the public sector. Verne House (Montana State University) has defined public policy as:

> "...A rule of operation for the public sector. Public policy includes custom and tradition or it may be institutionalized into law, administrative roles, or judicial decision. Public policies are generally adopted and implemented through government."[2]

> "Policy education is to help resolve public issues. It helps by assisting people to identify problems rather than symptoms; it improves the informational basis for public choices and encourages people to participate in policy-making. The philo sophical basis of policy education is Jeffersonian in that it is an expression of faith that society will be well served by open and accessible government and education."[3]

Public policy education is not expected to play an advocacy role or to make public policy decisions. Instead it serves to "help people to understand the society in which they live, analyze problems which develop in it, and to evaluate alternative means of coping with these problems."[4]

Coastal development issues can be addressed through Extension education methods using a public policy education process because of several factors. Coastal issues are affected directly or indirectly by public policy decisions made at numerous governmental levels—local, regional, state and federal. Community leaders playing decision-maker roles regarding coastal issues include elected and appointed public officials (city and town councils, commissions, advisory commit-

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[2]V. House, Shaping Public Policy: The Educator's Role. Bozeman, MT: Westridge Publishing, 1981.

[3]Ibid.

[4]C. E. Bishop, "Public Policy Education and the Land Grant System," Increasing Understanding of Public Problems and Policies—1978, Oak Brook, Ill: Farm Foundation, 1978.

tees), community leaders (neighborhood associations, environmental groups, etc.) and representatives tivesof labor, religion, and industry.

Public policy Extension programs can provide objective information while allowing a wide range of participants to take an active role in the educational process through interaction with each other and with educational, technical and policy specialists.

Educational Approaches in Connecticut

Coastal trends educational programs carried out by the Connecticut Sea Grant Marine Advisory Program started when Cooperative Extension agents working with commercial fishermen identified a growing need for fishing dock facilities. Redevelopment trends in cities like New Haven, Stamford, Greenwich, Norwalk and New London resulted in fewer dock facili ties for commercial fishermen. This trend started in the late 1970s and escalated during the mid-1980s economic boom. Representatives of the state's recreational boating and commercial fishing industries, along with municipal and state planning and resource management specialists, began to discuss coastal development issues that were occurring in urban and suburban waterfront areas.

As the current decade progressed, isolated problems merged into broader trends affecting many people. Issues that have emerged along Connecticut's coastline (and are common in other northeastern states) include:

1) Protecting water-dependent uses and activities (commercial and recreational fishing docks, marinas and boatyards),
2) managing harbors for multiple uses and avoiding conflicts due to overcrowding,
3) protecting tidal wetlands from the impacts of waterfront and inland development,
4) ensuring public access to the waterfront and Long Island Sound, and
5) preserving historic areas and natural areas for future generations.

These issues occurred in areas as diverse as urban/suburban coastal areas in western coastal counties (Fairfield and New Haven) and less developed eastern counties (Middlesex and New London). Extension agents conduct needs assessments through a variety of informal and formal techniques.

Individual meetings and correspondence with commercial fishermen and coastal planners (Stamford and New Haven) during the early 1980s identified the initial impacts of waterfront revitalization efforts upon fishermen in these cities as a critical issue.5 Municipal coastal management studies documented concerns about preserving water dependent uses on Connecticut waterfronts.[6,7]

A special supplement to the *New York Times* and *Bridgeport Post* by the City

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[5]Personal communication, Kenneth J. Buckland, Environmental Planner, City of Stamford, Connecticut, April 19, 1983.

[6]K. Jeziemy, et al. An Analysis of the Long Wharf Fishery Development. John F. Kennedy School of Government, Harvard University, Cambridge, Mass. May 1981 (Masters Degree Major Paper).

[7]J. Wallace. Fisheries Economic Development for Stonington, Connecticut. Education Development Center, Newton, Mass. N. D.

of Bridgeport reviewed proposed redevelopment plans for that city's blighted waterfront.[8]

Meetings with commercial fishermen concerned about potential losses of existing dock facilities took place in Greenwich, Norwalk, New Haven and New London during the 1980s.

Field surveys of commercial fishermen conducted in Norwalk and Greenwich identified permanent shoreside facilities needs (dockage, parking and fishing gear storage) of inshore fishermen as an emerging issue.

Initial educational efforts responded to the growing concern of fishermen that they would be pushed out of their existing dock facilities as redevelopment efforts occurred in the state's coastal cities. Educational methods used included surveys of fishermen to document fishing facility needs; meetings between public officials, fishermen and fishing specialists regarding alternative solutions to these issues; organizational meetings designed to assist fishermen in setting up a fishing cooperative; and tours of existing permanent dockside facilities in Connecticut and nearby states.

Initial efforts expanded into a broader Coastal Development Trends program addressing critical public policy issues affecting the people of Connecticut. Coastal trends educational programs carried out by the Connecticut Sea Grant Marine Advisory Program have utilized the following approaches:

1) Surveying public officials, community leaders, marine industry participants, and developers to identify critical coastal trends issues appropriately addressed by marine Extension programs.
2) Organizing advisory and planning committees which help identify key issues and assist in planning educational programs like conferences and field tours, and applied research projects.
3) Implementing a series of Coastal Trends in Connecticut conferences covering topics like:
   - coastal trends in Connecticut
   - harbor management
   - urban waterfront development along the Thames River
   - preserving water-dependent uses on Connecticut waterfronts
4) Organizing workshops and meetings covering critical development issues of importance to commercial fishermen at association meetings, an annual fishing forum and presentations at other meetings sponsored by local fishermen and public officials.
5) Initiating field tours which review development/harbor management issues at specific coastal sites.
6) Cooperating with Project Oceanology in implementing on-the-water workshops (aboard the Educational Vessels ENVIROLAB I and II) for public officials and community leaders covering topics like: coastal development, environmental issues, harbor management and the Long Island Sound Study.
7) Developing applied research projects in cooperation with public officials and marine industry leaders which are designed to collect and analyze information to be used by coastal decision makers.

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[8]"Venture Bridgeport," Supplement to New York Times and Bridgeport Post, 1984.

8) Writing publications being used in the other educational activities.

Extension education projects have been cooperative efforts involving field agents and campus specialists and researchers, marine industry representatives, public officials at numerous levels and community leaders of various organizations. This broad mix of people have been involved in identifying issues, assisting in planning programs, and participating as speakers, panels and members of the audiences.

Recommendations for Initiating Coastal Trends Educational Programs

A combination of changing use patterns of coastal lands and urban waterfront areas and a continuing turnover of local decision makers creates a need for educational programs covering coastal development trends. These programs can successfully increase municipal public officials' understanding of coastal development trends, impacts and alternatives if they utilize proven Extension and public policy educational methods.

Educational programs should be based upon needs assessments that identify critical issues facing coastal areas. Some needs may be common to many coastal communities while others may be site specific and be of interest to a more limited audience.

Needs assessments can be accomplished through:

- mail surveys of public officials, community leaders, business officials and the interested public,
- field visits to coastal areas,
- interviews and meetings with public and private officials, community leaders and the public,
- surveys of research-based literature on coastal issues, and
- surveys of Sea Grant and Cooperative Extension specialists familiar with coastal trends issues.

They should also be designed to involve the broad spectrum of people affected by changes in coastal land use patterns, including people who use coastal resources yet live inland from the coast. In addition, these programs should utilize research-based information and other credible information sources regarding coastal land use patterns, impacts of current and projected land use patterns upon society and coastal resources, and relevant public policies and alternative policies, including how other communities have handled similar issues.

Finally, the programs should use educational methods appropriate for specific situations and audiences, which may include:

- field tours
- conferences and workshops
- mass media (newspapers, magazines, radio, television and cable television)
- publications (brochures, fact sheets, newsletters, and technical reports)
- lecture series
- advisory committees

- presentations and exhibits at meetings of community associations, town commissions, fairs, etc.

Summary

Changes in coastal land use patterns will be influencing society's use of our coasts for several generations. Educational programs using Extension and public policy education approaches can ensure that a wide range of people affected by changing use patterns can play a role in determining how coastal resources are utilized as well as conserved for future generations.

Educational programs that utilize research-based information and experience-based knowledge of public officials, community leaders and the general public can contribute to more informed decisions affecting these resources.

DEEP DRAFT ANCHORAGE SHORTAGES THE CASE OF LOWER MISSISSIPPI AN APPLICATION OF QUEUEING THEORY

Paper Presented to the
Coastal Society's 11 National Conference
Boston, Mass. October 23-26, 1988

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October 1988

Introduction

A planned midstream transfer facility opposite the New Orleans General Anchorage required that the lower one mile of the anchorage be eliminated. Concerns were expressed, however, that the number of available anchorage slots would decrease and vessels may have to anchor elsewhere, thus increasing the cost to shipping. The choice of alternatives is limited to areas down the river from the General Anchorage. Additional shipping time and cost deter shipping lines from anchoring vessels above their destinations.

The three closest anchorages below the General Anchorage are Lower Nine Mile Point Anchorage, Lower Twelve Mile Point Anchorage, and Belle Chasse Anchorage. The Nine Mile Anchorage extends from Mile 82.7 to Mile 85.0 above Head of Passes. The Twelve Mile Anchorage extends from Mile 78.5 to Mile 80.8 above Head of Passes. The Belle Chasse Anchorage is located along the bank of the river between Mile 73.1 and Mile 75.2 above Head of Passes.

The Model

The basic model situation is as follows. X_j is the number of ships in anchorage j. Each anchorage has a given number of slots, or a given number of parallel servers. The service time is staying time and the service discipline is first come- first served. The number of parallel servers are the effective anchorage slots. The arrival rates and the staying times are assumed to be Poisson and exponential (M/M), respectively. There is a given number of parallel servers or anchorage slots (c) and the source, i.e., the total number of customers in the anchorage, cannot exceed the number of slots available. The population, the total number of ships that might be candidates for the anchorage, is infinite. (The situation in Kendall/Lee notation is $(M/M/c):(GD/c/\infty)$). Let the expected arrival rates be (α) and the expected service time = holding time ($1/\mu$). (All parameters have subscript $j=0$ ..m, where m is the number of down stream alternatives to General Anchorage). The steady state probabilities can now be written as:

$$p_o = \{\sum_{i=0}^{c-1}(\sigma^i/i!) + \{\sigma^c(1-\sigma/c)\}/c!(1-\sigma/c0\}^{-1} \qquad \sigma/c<>1.0$$

(1)

The probability that the anchorage is full $P\{X=c\} = p_c$. Let R = number of daily rejects at General Anchorage.

Then the expected rejects $E(R) = \alpha p_c$.

(2)

B is the number of ships that each year have to be turned away from General Anchorage after a reduction in slots have taken place. $\theta$is the average total additional cost per ship incurred in this instance, i.e., the cost of using some other down stream anchorage than General Anchorage. Thus, θ_1 is the additional cost of using anchorage 1 or some other down stream anchorage instead of General Anchorage. θ_2 is the additional cost of using anchorage 2 or some other down stream (#2 and downward) instead of General Anchorage , etc..

Thus, the total annual cost $T = B\theta$

(3)

$B\theta$ and are stochastically independent and the expected value $E(T) = E(B)E(\theta)$.

(4)

The $E(B)$ is derived directly from the queueing model since the expected number of arrivals per day and the probability that the General Anchorage is full (p_c) is known. The annual number of rejects are:

$E(B) = E(R)^{*}365 = \alpha p_{c^*}{}^{365,}$

(5)

The expected cost depends on where the ship will eventually anchor given that it cannot anchor at General Anchorage, i.e., Nine Mile Anchorage, Twelve Mile Anchorage or Belle Chasse, which are the alternatives considered here. The queueing model gives us the probability that each of these anchorages are full. The expected cost per ship can be derived in the following chain fashion.

Let $p_j = p_c(j)$ be the probability that anchorage j is full and C_j the differential cost per ship incurred from using anchorage j instead of General Anchorage ($j=0$ for General Anchorage, $j=1$ for Nine Mile Anchorage $j=2$ for Twelve Mile Anchorage $j=3$ Belle Chasse Anchorage, C_0 p 0).

Thus, $E(\theta/\theta_1) = (1-p_0)C_0 + p_0\theta_1$

(6)

$E(\theta_1/\theta_2) = (1-p_1)C_1 + p_1\theta_2$

(7)

$E(\theta_2/\theta_3) = (1-p_2)C_2 + p_2\theta_3$

(8)

$E(\theta_3/\theta_4) = (1-p_3)C_3 + p_3\theta_4$

(9)

Let $p_3 = 0$, which amounts to assuming that the Belle Chasse Anchorage always has one slot available. Thus, the costs per ship is the probability weighted average of all cost elements, weighted by the probability that they may be incurred.

$$E(T) = E(B)p_0\{(1-p_1)C_1 + p_1((1-p_2)C_2 + p_2C_3)\} \tag{10}$$

In order to scan some possible instances with regard to costs, three cost scenarios for C_{ij} ($i=1..3$) are developed. Scenario One gives costs for the base case where no tugs are used and no bunkering takes place. Scenario Two incorporates bunkering, i.e., it is assumed that all ships rejected from General Anchorage would in fact have taken bunkers at that anchorage and will thus do likewise wherever they anchor. In Scenario Three the ship rejected at General Anchorage would have had to use tug assistance. Due to the Corps of Engineers revetment plans, there is a possibility that the Nine Mile Anchorage may be closed some time in the foreseeable future. In the model this is facilitated by setting $p_1 = 1.0$ and distributing the Nine Mile Anchorage arrivals down to Twelve Mile and Belle Chasse Anchorages in proportion to their current arrival rates.

Model Estimations

Data

Data on anchorage occupancy and utilization were collected from various sources, i.e. the U.S. Coast Guard, the Crescent River Port Pilots Association, the launch service companies etc. The data had around 2000 data points (ships) collected on 59 effective days. For comparison purposes the data was collected for all 22 officially designated anchorages on the Lower Mississippi. A complete overview of these and other parameters for the entire Lower Mississippi Anchorage System is available from the authors.

Occupancy

During the observation period there was ample free capacity, although some of the individual anchorages were well utilized. The analysis revealed that 135 ships were anchored in the observation period at the Nine Mile Anchorage. This anchorage was empty on one day. There were 115 ships anchored at the General Anchorage and it stayed empty for four days. Twelve Mile Anchorage had 69 anchored ships and nine days empty. General Anchorage and Nine Mile Point Anchorage have the most number of ships at anchorage on most occasions. On 19 occasions there were six or more ships at Nine Mile Anchorage compared to 13 occasions for General Anchorage. Twelve Mile Anchorage only had five days during the period when there were five or more ships anchored. Belle Chasse Anchorage, which had 20 empty days, had a maximum of five ships on two occasions only. Thus the data indicate that of the anchorages important to this study, Nine Mile Anchorage and General Anchorage are well utilized facilities, whereas Twelve Mile Anchorage and Belle Chasse Anchorage are relatively underutilized.

Capacity

The capacity limitations used in this study are set according to industry sources, the pilots associations and published materials. The number of slots in an anchorage is, however, critically dependent upon the size of the ships. For the purpose of this study which concentrates on an average ship size of 20- 30,000 DWT. The data indicated that all anchorages on the Lower Mississippi River were utilized considerably below their capacities which were: 13, 12, 6, and 10 for General Anchorage, Nine Mile Anchorage, Twelve Mile Anchorage and Belle Chasse Anchorage, respectively. At no time during the observation period did any of the anchorages experienced capacity limitations. There were however, three days when the General Anchorage had eight ships at anchorage whereas the Nine Mile Anchorage at a capacity of 12, had eight ships only on one occasion.

Duration of anchorage stays and arrival rates

The length of time that ships stay at anchorage vary with anchorages, ship types and trades. The stay time is generally related to the freight market fluctuations. When the freight rate and the demurrage are low, charterers tend to balance off shorebased logistical problems to the ships. In times of high freight rates and demurrage, the actual lay-days have a tendency to creep downwards.

General Anchorage

The General Anchorage is for the most part well utilized. The ships anchored here tend to stay for a relatively long period of time. The analysis indicated that most ships stayed at this anchorage for one day or less. However, a significant number of ships (36.5%) stayed two days or more. This yields an average staying time of 2.0348 days for the sample. The exponential curve passed the chi-square test by a large margin. The difference between the theoretical and the actual figures were significant only for the lower end of the curve. For staying times larger or equal to two days the curve fitted perfectly.

The data also showed that only on ten days during the observation period did the General Anchorage experience zero arrivals. For the rest of the 49 days, arrivals ranged from one per day to eight per day, which occurred only once. On 15 days there was one arrival and on another 15 days there were two arrivals. On the average there were 1.9492 ships arriving per day. The theoretical Poisson distribution followed the actual arrivals quite satisfactorily. The test statistic is 1.7718, whereas the critical point at 5% is 15.5

Nine Mile Anchorage

This anchorage is one of the busiest in the system. The average staying time here is 2.2672 days, somewhat longer than the average staying time at the General Anchorage. Compared with the actual frequency of staying time, the theoretical frequency tends to underestimate the number of ships that stay one day but delineates perfectly the rest of the distribution. Furthermore, the theoretical distribution stands the Chi-square test solidly at 0.8643

The arrival intensity at this anchorage was 2.2203 ships per day. Only on four days were there no arrivals at Nine Mile Point Anchorage. There was one arrival on 18 days, two arrivals on 17 during the observation period. On two occasions this anchorage had six arrivals per day. Again the Poisson distribution fits the actual arrivals quite nicely, although the Chi-square statistic (6.8323) is higher than at General Anchorage, it has no problem of passing the test at 5% significance.

Twelve Mile Anchorage

This anchorage, displays a staying time structure that is on the average shorter than the staying time at the previous anchorages. The average length of stay here is 1.9420 days and the exponential curve fits the data very well which the Chi-square test verifies. (Chi-square = 1.1071)

This anchorage experienced 20 days during the observation period of no arrivals. On 19 occasions there was one arrival per day. Two arrivals occurred on 14 days. At the most, the anchorage had five arrivals on one day. On the average 1.1695 ships arrived each day. The fitted function followed the data fairly well with a test statistic of 2.8853, well within the region of acceptance.

Belle Chasse Anchorage

Of the analyzed anchorages, Belle Chasse Anchorage is the least used. Ships tend to stay at the anchorage only one day. Four ships in the sample stayed for six or more days compared to three at Twelve Mile Anchorage and 13 at Nine Mile Anchorage. Again the theoretical fit of the exponential curve was excellent and the average stay is 2.0323 days per ship. (Chi-square = 0.4353)

There were 41 days when no arrivals were recorded. On 12 days one arrival occurred. There were four arrivals on three occasions and three arrivals on one occasion. On the average, the Belle Chasse Anchorage had 0.5254 arrival per day during the observation period. Although the Poisson function does not follow the data as well as for the other anchorages, the function clearly passes the Chi-square test. (Chi-square = 8.8)

Cost definition

The data on costs has been compiled from published tariffs and analysis of disbursement summaries provided by shipping agencies. In addition, numerous interviews with officials of shipping agencies, launch companies, tug and towage companies, bunkering companies and ship chandlers were conducted. The cost elements included are: harbor fees, pilotage, launch service charges, land transportation charges, INS inspection fees, Custom's inspection fees, USDA inspection charges, National Cargo Bureau charges, bunker charges, towage and additional ship chandler transportation costs.

Analytical Results

The current level of ocean going ship traffic on the Lower Mississippi River is relatively low compared with earlier periods. This lower traffic level is clearly reflected in the data. The low traffic level was the result of two main factors: the slump in the oil industry and the high value of the U.S. dollar. The conventional thinking is that the lower value of the dollar will have a significant impact on U.S. export trade. Consequently, the anchorage traffic will increase. Since forecasting the ship traffic on the river is outside the scope of this study, changes in the traffic level will be evaluated through a sensitivity analysis on the arrival rates as well as the staying time rates.

In order to establish the departing point for the economic impact analysis a base case run of the model was undertaken. The base model run included actual arrival rates, service times and available anchorage slots. The probability of one arrival being rejected because General Anchorage is full is 0.06%. This means that without any reduction in anchorage space one ship per year will have to be rejected at the General Anchorage at a total expected cost to the shipping industry of $500 per year.

If, however, four anchorage slots are removed from General Anchorage under the previous arrival and lay-time conditions, 21 ships will be rejected per year at a cost of $10,238 to the shipping industry. The probability of General Anchorage being full under these circumstances have thus increased from 0.06% to 2.9%.

If Nine Mile Anchorage is closed permanently, the cost to the shipping industry will increase to around $17,373 per year under the base case cost scenario, whereas the tug assisted ships will have to pay $20,325 per year.

If the arrival rates increase for the total Mississippi River system by 25%, the following situation may occur. The probability of General Anchorage being full increases to 6.4% and the expected number of ships that will be rejected increases to 57 per year. The cost to the shipping industry, is $29,789 per year with the Nine Mile facility open. If, on the other hand, this facility is closed, the cost to the industry will increase to $47,135 per year.

An increase in the staying time has a slightly less severe impact on costs and ships rejected than in the case of arrival rate increases. Keeping arrival rates constant at the original level and increasing staying time by 25% leads to the following situation. The probability of a ship being turned away at General Anchorage is 6.4% and the expected number of yearly rejects is 46 ships. The economic impact here is $24,040 per year. Closing the Nine Mile Anchorage would increase the cost to $38,039 per year.

The final question asked of the model was what would happen if the arrival rates and the staying time rates simultaneously increased by 25%. With the Nine Mile Anchorage open, the yearly cost to the shipping industry of 105 ships rejected will be around $60,038. Closing the Nine Mile facility will increase cost to the industry by another $28,000 per year.

Summary and Conclusions

From the above analysis it can be seen that if the Nine Mile Anchorage is closed and the General Anchorage is reduced by four slots, in the most serious instance some 105 ships will have to find anchorage down river at a cost of around $86,761 per year. The likelihood that this scenario will materialize is fairly remote. First, the arrival rates and the staying rates would have to increase simultaneously by 25%, which is highly unlikely even with a revival of the oil industry in combination with a low value of the dollar. Most probably, the cost to the shipping industry will range from 10,000-$30,000 per year involving 8-30 ships.

The results show that with the present traffic intensity and anchorage patterns, the effect of reducing General Anchorage by approximately one mile will be negligible. If, however, traffic patterns change in the coming years, the shipping industry stands to incur an extra cost of $30,000-$40,000 per year depending upon industry anchorage preferences and staying time. The threat of Nine Mile Anchorage being closed due to revetment will increase the cost to the shipping industry. At no time, however, did the analysis show the additional cost incurred by shipping to exceed $90,000 per year.

A STUDY OF THE COEXISTENCE OF DEEP DRAFT NAVIGATION OF THE MISSISSIPPI RIVER AND HEALTHY COASTAL MARSHES

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Introduction

The coastal erosion and marsh loss problems of south Louisiana are well known and are a growing concern to scientists and professionals in the field as well as many elected officials. The Corps of Engineers was one of the first agencies to document and quantify the problem and remains one of the only groups actively attempting to lessen the loss through marsh creation and fresh water diversion projects. Still the problem continues.

The purposes of this paper will be to share some new data on the causes and site specific location of serious erosion and to look at the feasibility of maintaining both a deep draft navigation system and a productive coastal marsh ecosystem—can these two systems, in fact, coexist?

Wetland Development and Uses

Prior to the late 1800's Louisiana's coast had experienced some 5,000 years of growth as the overflows of the Mississippi River outpaced the erosive forces of Gulf of Mexico. Today, unfortunately, the Gulf is clearly winning the battle. Some 800,000 acres of coastal wetlands have been lost since 1900 with as much as one-half of that loss occurring since the 1950's. It is estimated that this loss represents about 80 percent of the total loss of marshes in the United States. These marshes support a wide variety of economic activities. An estimated 25 percent of the nation's fish harvest and 40 percent of the wild fur harvest with a combined value of over $425 million are taken annually from or are dependent on the Louisiana coastal marshes. Nearly 4 million waterfowl overwinter in these wetlands which support some 25 million man-days of recreation annually. Other marshland functions which, while harder to quantify are none the less quite important, include buffering hurricane storm surges, retarding saltwater intrusion, preserving water quality and providing esthetic values. Beneath the marshes and offshore waters of Louisiana are extensive oil and gas fields which supply 22 percent of the Nation's energy needs. Over 2 million people reside permanently in the area; Federal, state and local governments as well as commercial interest and individuals have invested billion of dollars in the existing infrastructure. It is the planner's challenge to develop measures to accommodate these apparently conflicting demands.

Causes of Marsh Loss

Much research has been done and much continues to document the causes and rates of coastal marsh loss. The major factors seem to be barrier island degradation, land use change, subsidence, sea level rise, sediment reduction, levee systems, oil and gas development, canals, saltwater intrusion, and storm damage. While the synergistic relationships may never be fully known, the results are—Louisiana has lost over 1 million acres and stands to lose another million by the year 2040. As coastal scientists and engineers, it is important to maintain a healthy academic interest in the "whys" of coastal erosion; as a planner it is equally important to consider the "whats" and the "hows"—what can be done to reduce land loss rates and how can societal patterns be influenced to better live with the constraints imposed by the erosion problem. Thus our definition of planning as the place where *RESEARCH* meets *REALITY*.

Current trends

Many previous studies have indicated that the loss of Louisiana's coastal marsh was a result of a general inland shoreline retreat due to sea level rise, subsidence and the erosive forces of the Gulf of Mexico. While this is certainly true recent data indicates that there is another dimension to coastal erosion— that of areas of highly localized but very severe erosion—"hot spots." These areas of high land loss form a generally east-west pattern across Louisiana roughly parallel to the coastline. The reason for some of these problems is readily evident -aborted agricultural ventures, depressions caused by oil and gas extraction—many however have no apparent cause. While many have postulated a reason, the most plausible so far comes from the realms of the geologists who cite an underground fault line along the northern edge of the area. Research at both Louisiana State University and the U.S. Army Corps of Engineer Waterways Experiment Station continues. While these "hot spots" are an interesting phenomena to contemplate, current work on determining the rate of wetlands loss has yielded much more important results. For the first half the twentieth century an estimated 4—500,000 acres of land was lost to the slow, relentless intrusion of the Gulf of Mexico due almost entirely to natural causes. Since that time a like amount of land has been lost with loss rates being greatest since the mid-1950's. This acceleration was due in large measure to oil and gas development and the construction of major water related infrastructure improvements. Current investigations show a dramatic reversal in the rate of land loss since that time! From a high rate of 50-60 square miles per year, preliminary figures indicate that the current rate has dropped by about 30%. Even though this rate is still much too high to be acceptable, it appears that the unrestrained development of the past several decades is a thing of the past. Whether this change is reflective of a genuine change in public policy or is simply a result of the depressed price of crude petroleum only time will tell.

Mississippi River Active Delta

The area that has experienced the greatest rate of land loss is the active delta of the Mississippi River below the Head of Passes. Over one-half of the land in this area has been lost since the mid-1950's. This loss results from a number of causes. The relatively new sediment deposits are easily consolidated, consequently subsidence rates are very high. Sea level rise and exposure to Gulf of Mexico storms also play a role. Hurricanes Betsy and Camille probably caused a major portion of the loss. This idea is supported by current research that shows that between 1956 and 1978 the area experienced a marsh loss of 51% while between 1978 and 1983 that rate was only 2%. Another factor is the need to maintain a deep draft navigation channel to provide access from mid-continent America to world seaports. In the absence of such maintenance Southwest Pass would shoal up to a depth of 15-20 feet, much the same as has occurred in South Pass. This shoaling would force major flows to overflow the banks and nourish the marshes. To maintain deep draft navigable depths it is necessary to keep the channel dredged to a depth of 45 feet below sea level (-45 N.G.V.D.). This dredging, along with a program to raise the banks along Southwest Pass results in much of the sediment in transport being carried to the deeper waters of the Gulf of Mexico where it contribute little, if anything, toward reducing coastal land loss rates.

Value of Mississippi River Shipping

Historically, the economy of the State of Louisiana has been highly dependent on the oil and gas industries. Unfortunately, the price per barrel of crude oil has dropped from a high of $35.34 in 1981 to only $13.06 on October 1, 1988. The effects of this price drop on the state economy have been devastating. The other large contributors to the financial health of the state are tourism, agriculture and shipping. In 1985, the latest year for which records are available, New Orleans, Baton Rouge and the smaller ports on the lower Mississippi River shipped over 111 million tons of foreign commerce valued at $21.2 billion, which is nearly 20% of the United States international waterborne trade. The Baton Rouge—New Orleans "megaport" is the largest port system in the world—almost twice the size of the largest individual port of Rotterdam. 1987 data, as yet unpublished, is expected to show that the Port of New Orleans has regained the distinction of being the largest port in the United States.

About $2.5 billion in direct economic impacts to the coastal Louisiana area and another $3 billion of indirect impacts are traceable to oceangoing commerce. More importantly this commerce generates some 68,000 jobs. Economic impacts this great cannot be ignored. They, in fact, dictate that any solution to the coastal problems must be constrained by the need to not seriously impact deep draft navigation.

Possible Solutions

Within these constraints much can be done—much is currently being done. Under existing Corps of Engineer authorities attempts are being made to mitigate land loss by pumping dredged material into carefully planned disposal areas For example, over the past 12 years some 1,500 acres of wetlands have been created as a by-product of the maintenance dredging of Southwest Pass. A like number of acres have been created in other areas of the Louisiana coast. Another approach being taken is the diverting of fresh water and sediments from the Mississippi River as a means of mimicking to some extent the river's historic overbank flooding patterns. The Corps has developed a fresh water diversion plan which consists of structures at Caernarvon and Bonnet Carre' on the east bank of the Mississippi River and at Davis Pond on the west bank. The Caernarvon structure is under construction, the Davis Pond structure is in the final design stage and the Bonnet Carre' structure has recently been authorized by the Congress. On each of these projects the cost is being shared between the Corps and local governments. While these efforts are small in comparison to the overall problem of coastal land loss they are, none the less, important first steps. Within the last year the Mississippi River channel has been increased from a depth of 40 to a depth of 45 feet. Future maintenance dredging is expected to increase accordingly, making more material available to create new marsh. Future deepening to 55 feet would allow the creation of an additional 35,000 acres.

On a larger scale, under the Mississippi River Delta study, other measures are being studied to increase the land building capacity of the Mississippi River. These measures include alternative navigation outlets, including locks to free the river's flows and sediment for land building, and major diversions of flows and sediment to shallow water areas while maintaining navigation in the river's existing channel. This is being considered both with and without locks.

Public Perception

In order for a public works plan of the magnitude that would be required to significantly impact coastal erosion to be successful broad public support will be required. To judge the depth of existing support surveys of public attitudes were made. While admittedly not accomplished with statistical rigor, the survey none-the-less documents the real problem of how the coastal erosion situation is viewed by many people. Two surveys were made—one limited to the State of Louisiana and one involving areas of the east coast and the Great Lakes. In each survey the respondents were asked to list, in priority order, the areas where it was felt public funds should be expended—10 points for the highest priority, 1 point for the lowest. The total points for each category were summed up to determine the overall ranking. The results are given below.

National	Louisiana
1. Defense	Police protection
2. Social Security and Entitlements	Education
3. Health and Welfare	Tax reform
4. Education	Highways
5. Transportation	Entitlements
6. Energy	Health
7. Coastal erosion	Welfare
8. Foreign policy	Coastal Erosion
9. Parks and recreation	Public works infrastructure
10. Other	Other

From these surveys it is apparent that the magnitude of the coastal crisis has not yet been realized by the large majority of the "public." Professionals in the field have not yet been able to convince enough people of how large, how widespread and how real the problem is. As with most questions of broad public policy, major changes are not likely to be forthcoming until there is an upsurge of public demand. As long as the vendible outputs from the coastal area are available at reasonable costs policies will not change.

Summary

The problems of erosion of Louisiana's coast are well documented; the technology for solution is becoming available. The remaining unknown is the public's perception of the problem and if, in fact, the public is willing to expend large sums of tax money or even to tax themselves specifically to pay the cost of combating coastal erosion. There is no doubt that deep draft navigation and a productive coastal marsh ecosystem can coexist—but only if each professional in the field becomes involved a three pronged attack to:

1) Continue existing studies to better understand the causes and define the solutions to coastal erosion problems;
2) Support economic development to boost the economy, particularly in south Louisiana, to make more funds, through increased tax revenues, available to programs designed to combat coastal erosion; and
3) Actively engage in educational programs, to develop the kind of grass roots support needed to gain the political support essential to effectuate the public policy changes necessary to elevate the problem of coastal erosion to a high national priority.

It is essential and it is now time for scientist and coastal professionals to elevate their concern from the purely technical area to the political arena because that is where the solution lies. Technical conferences, such as the one, are important for exchanging information among coastal professionals. It is time now, however, to stop talking to each other and to get out of the word--there is a crisis on the coast and the time for action is *NOW*!

Salmon Habitate Mitigation at The Port of Tacoma, Washington

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Introduction

The purpose of this paper is to present the mitigation negotiation process that we participate in at the Port of Tacoma, Washington, and to demonstrate how the constraints of the process lead to the mitigation projects proposed. Also, we present our perspectives on mitigation for highly altered habitats. For this paper, the word mitigation is being used as it relates to replacement of habitat lost due to a construction project. Although other mitigative measures (e.g. construction timing) are incorporated into project designs these are not covered in this paper.

The Port of Tacoma is located on Commencement Bay in south central Puget Sound adjacent to the city of Tacoma and the estuary of the Puyallup River. The estuary and associated mudflats have been dramatically altered over the last one hundred years by dredging and filling to create land and waterways for industrial and port development. Today the original estuary is the site of a modern growing Port and many industries. In addition to physical changes, the area has been dramatically altered chemically. Portions of the uplands and the waterways have been designated a superfund site and remedial investigations and feasibility studies are being conducted.

Despite the changes that have occurred, the Puyallup River and the bay support abundant runs of four species of salmon (chinook, coho, pink, and chum) and two species of anadromous trouts (steelhead and cutthroat). Of the species listed, chum, pink and chinook salmon are considered to be most dependent upon the nearshore and estuarine habitats present in the bay. The habitats used today are much different than those used 100 years ago. The substrates are dominated by large riprap blocks on steep slopes rather than marshes and mudflats. Although the habitats are greatly altered, use is heavy enough to warrant mitigation when impacts will result from a port expansion project.

Mitigation Negotiations

Port projects must comply with the conditions of several overlapping permits each of which specifies mitigation of unavoidable impacts. These permits include the Clean Water Act Section 404 permit, River and Harbor Act Section 10 permit, state and local Shorelines Permits, and state Hydraulics Project Approval. Also, a state or federal Environmental Impact Statement may be required depending upon project impacts. The agencies involved include: Corps of Engineers (COE), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Environmental Protection Agencies (EPA), Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), Washington Department of Ecology (WDE), Puget Sound Water Quality Authority, Puyallup Indian Tribe, and the City of Tacoma. The mitigation negotiations have evolved in an attempt to make timely progress on mitigation issues as they relate to all the permits; however, the negotiations are most closely tied to the Section 10/404 permitting process. The participation of many resource agencies, each with a different perspective, makes the negotiations very challenging. The challenge is increased by the dynamism in the rapid evolution of port facilities, which puts time constraints on the negotiations. The net result of the legal processes, time constraints, and the number of participants is that the agencies have a strong negotiating position.

After it has been determined that a construction project requires mitigation, Port of Tacoma staff and its consultants meet with representatives of the agencies and the Puyallup Indian tribe. The discussion is focused on agreeing on impacts and mitigation concepts. Soon after the concept is presented, public review is provided through the EIS, Section 10/404 permitting process, and the state and local shoreline permit processes. Following the public meetings, details are worked out in informal meetings with the agencies. After agreement is reached on the mitigation and the required monitoring program, a mitigation plan is prepared in the USFWS format, which includes an explicit statement of the action, mitigation, success criteria, monitoring program, and contingency plan. The mitigation plan is typically appended to a permit (e.g. 404 permit) or an EIS.

The mitigation process emphasizes cooperative problem solving to develop the design. After project completion, the monitoring and evaluation are followed by modifications to the mitigation area if appropriate. One of the keys to mitigation negotiations, is the demonstration of the proponents willingness to support the mitigation until it is proved successful and a willingness to correct shortcomings.

Constraints

During the negotiations, we are guided by biological, regulatory, and political constraints. First, salmon and steelhead return to their natal streams to spawn; therefore, when impacts occur to habitats used by particular runs of salmon or trout, mitigation must be provided for the same runs. Second, the federal courts have affirmed the treaty Indian tribes right to harvest one-half of the harvestable run of salmon and steelhead in most river systems in western Washington. The federal government is charged with protecting the habitat for the tribes. Since each tribe has adjudicated "usual and accustomed" fishing areas, there is interest in on-site mitigation measures from a political as well as biological perspective. Further, juvenile salmon are believed to migrate along the shore and an unbroken migratory path that provides foraging opportunities is believed to minimize their exposure to predators and maximize their potential for growth. These concerns lead to a strict requirement for on-site mitigation, typically very close to the impacted habitat.

In addition to on-site mitigation, in-kind mitigation is typically required. The mitigation project must provide the same function (e.g. estuarine rearing habitat) for the same species and age groups as that which was impacted. In the past, mitigation for impacts on salmonids typically involved construction of a hatchery. This practice fell out of favor as some hatcheries did not live up to expectations and the environmental view became more focused on habitat for several species rather than focusing on specific resources. Also, there is presently an emphasis on enhancing and protecting wild stocks of salmon and therefore the emphasis is on habitat replacement rather than hatchery construction.

In general for port projects, mitigation has been required on an acre for acre basis for impacted areas. The focus has been on the intertidal zone (defined from a regulatory perspective from - 10 to +8 feet Mean Lower Low Water, MLLW) although mitigation has been provided in other tidal elevations for flatfishes. The mitigation habitats must be built at essentially the same time as the expansion project to avoid losing a season of use on the impacted habitats. The mitigation must be in place by March 15, to achieve this goal for juvenile salmonids. This constraint complicates the scheduling of the construction of the project and the mitigation, particularly if they are tied by construction actions (e.g. dredge material comprising a portion of the mitigation area).

The candidate mitigation sites are dictated by the location of the construction project and the number of acres of habitat that are impacted. Although an inventory of possible mitigation sites is conducted for each project, in practice the alternative locations are few. Fitting the mitigation into the available site then becomes an engineering and biological design challenge. An additional complicating factor is the bathymetry of the bay; the edges are steep, therefore, large quantities of fill are typically needed to provide intertidal habitats.

Examples of Negotiated Mitigation Projects

Terminal 3 / Slip 5

The Slip 5 mitigation area was designed as mitigation for the impacts from fill of a small boat basin involved with creating Terminal 3. The boat basin contained about 2.5 acres of intertidal habitat. The mitigation was designed to create additional area of intertidal habitat in Slip 5, an obsolete berthing area, by filling to decrease the slope. A second feature of the project was the reduction of wave energy at the site to increase substrate stability and increase use by juvenile salmon. The impact of the fill on the mitigation area was taken into account when determining the mitigation need. In other words, the area of intertidal habitat present in Slip 5 after construction was equal to the loss in the small boat basin and that lost in Slip 5.

Figure 1 shows schematic and cross-section views of the mitigation project. Construction of the mitigation involved recycling of on-site materials to lower costs and solve other construction-related disposal problems. For example, the dock structure present in Slip 5 was retained and its wave attenuation ability was enhanced by additional pilings. Also, demolition rubble from an on-site grain elevator was used to create a groin, also for wave attenuation, and as fill. Finally, dredge material from a new berth was used as fill. The surface substrates (medium to large gravel) were selected with regard to stability and biological productivity. The eastern side of the mitigation site was not fully used and was designed to be expandable to provide mitigation for a future project.

This mitigation area has been built (construction completed in March of 1988) and initial monitoring has begun. Early indications are that the project is functioning as expected and providing habitat to the proper size groups and species of salmon. The formal monitoring program will begin during the spring of 1989. The basis of the success criteria for this projects is the production of prey organisms for juvenile salmonids. The habitat will be monitored for three years following construction at which time the habitats must meet the success criteria outlined in the monitoring program. If the project fails to the criteria, modifications and further monitoring are required.

The permitting process for the terminal 3/Slip 5 project took approximately one year. Construction cost was 2.5 million dollars (nearly one million dollars per acre of habitat). This cost does not include the economic impact of the loss of Slip 5 as a potential terminal facility. Project costs were high due to the large volumes of fill needed to raise the elevations in the deep slip, and the special design and construction techniques needed to place fill around an existing pier structure. It is clear that high cost can be a serious problem with such a negotiated settlement. Although, from the perspective of the Port of Tacoma this was a successful solution to the mitigation needs for the construction of Terminal 3.

Milwaukee Waterway

Mitigation negotiations were conducted during early 1988 regarding offsetting impacts of the Milwaukee Waterway fill project. The construction project was a container terminal facility incorporating a confined nearshore disposal area for moderately contaminated dredge material. The habitats impacted included several acres of intertidal habitat and subtidal habitats.

Figure 2 shows the mitigation design resulting from the negotiations. The project included mitigation in two elevation zones: -10 to +8 and -20 to -10 feet MLLW, the latter intended to offset loss of flatfish habitat. The project involved engineering the fill so that it is an integral part of the containment dike for the contaminated fill. Also, about one-half million cubic yards of uncontaminated dredge material is to be used to create the mitigation fill. This material is to be capped with substrates selected for their wave stability and productivity. As with the Slip 5 project, the mitigation project is used to offset habitat losses while providing an opportunity to solve construction-related problems (e.g. disposal of dredge material).

On this project, time constraints led to providing more mitigation than was probably necessary to offset project impacts. However, unresolved differences of opinion regarding use of certain habitats by juvenile salmonids combined with inadequate time for additional study made agreement on full utilization of the available mitigation area the expedient solution during negotiations. The project has been put on hold and costs have not been calculated. Costs will probably be somewhat lower per acre than for the Terminal 3/ Slip 5 project, but will be substantial.

Conclusions

The informal nature of the negotiations allows the group to participate in solving the mitigation problem. Agency involvement occurs early enough that mitigation design modifications are possible. Fortunately the agency and tribal staff involved are knowledgeable regarding habitat requirements of the target species. This makes it possible to reach agreement on what are, in essence, experimental mitigation projects. The participants must rely on their intuitive sense of what will work and a monitoring and evaluation program that is informative enough to guide modifications. So far at the Port of Tacoma, the negotiations have led to timely common-sense solutions to complex biological and regulatory problems. Overall we have come to several conclusions regarding mitigation. First, opportunities exist for mitigation that solve construction-related problems and are compatible with port operations. Second, simple designs are best as they are amenable to the tinkering and modifications that may be necessary to achieve successful mitigation. Finally, mitigation does not have to look natural to function as habitat.

The major weakness of the negotiations is that the economics of the situation are not adequately considered. The solutions are typically quite expensive even though in comparison to the construction cost of the project they may appear small. Due to the constraints of in-kind mitigation, we never ask the question: is this the best way to enhance the resource? Instead the focus is on replacing habitat areas rather than on maximizing the benefit from a mitigation action. For an urban estuary, the range of possible mitigation strategies could range from pure fish production (e.g. salmon hatchery) to restoration of natural habitats. It is our view that when considering mitigation for highly altered habitats, mitigation will fall between the two extremes. However, the cost and expected benefits of in-kind mitigation should lead us to at least consider other cheaper, and possibly more beneficial, out-of-kind mitigation options.

Acknowledgements

For both mitigation projects, Port of Tacoma Engineers were instrumental in design, and supporting geotechnical and geochemical assessments were provided by Hart Crowser, Inc. of Seattle WA. Final design of Slip 5 was completed by ABAM Engineers of Federal Way, WA, and Manson/General contractors built the project. Ogden Beeman and Associates Inc., of Portland OR, conducted the dredge and fill planning for Milwaukee Waterway. The Johnson Partnership, of Seattle, prepared the supplemental EIS.

HABITAT ENHANCEMENT TECHNOLOGY: NEW METHODS FOR RESOLVING PORT DEVELOPMENT AND FISHING CONFLICTS

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Introduction

Port and harbor development and redevelopment projects often cause adverse environmental impacts due to the resulting loss or degradation of aquatic habitat. This frequently results in conflicts between developers and environmental or fishing interests. Options for mitigating the loss of habitat and associated degradation in carrying capacity are limited in many cases due to the lack of areas available or suitable for common habitat compensation measures such as wetland creation or submerged aquatic vegetation (SAV) planting techniques. The use of prefabricated artificial reef structures designed to increase the carrying capacity of shallow open-water areas for selected ecological communities and/or important fish/shellfish species can serve as a cost-effective tool for compensating, in part, for habitat losses and thus aid in resolving conflicts. The rationale for applying this technology, limitations pertaining to its use, and an initial application of it in Delaware Bay are briefly described.

Problem Description

The need for mitigation technology in ports and harbors is frequently based on the requirement to expand existing port capacities and efficiencies in order to meet increasing economic demands associated with growing international trade. However, military requirements based on national security priorities as well as residential and recreational projects related to local economic growth also generate port and harbor development and channel modifications.

To meet these demands, port authorities, military, and other government organizations as well as private firms have been planning the redevelopment and expansion of shore-based facilities as well as the deepening and expansion of channels and turning basins. These plans often require dredging, dredged material disposal, and land reclamation or pile-based construction that may have temporary or permanent adverse impacts on living marine or estuarine resources. Construction activities can temporarily reduce water quality and increase turbidity, cause the burial of benthic resources, or alter circulation patterns affecting benthic and fisheries production as well as fish migration.

At the same time, public concern about the environmental quality of our coastal areas is increasing, the population in coastal areas is growing significantly, and the demand for recreational fishing and boating opportunities is increasing. These trends have increased the frequency and intensity of conflicts that may seriously delay and thereby escalate the cost of coastal development projects. This situation challenges developers as well as environmental and natural resource managers to establish ecologically sound development plans that minimize habitat loss and provide effective mitigation for those impacts which cannot be avoided.

For the last decade, Aquabio and Versar have been involved in a number of port and harbor impact analysis and/or mitigation planning projects. During the course of these projects, a number of conflicts have arisen between developers and groups concerned with the environment or fishing. These conflicts were generally associated with one or more of the following problem areas:

- The impact of the proposed activity was not adequately described or quantified.
- Several groups were involved in the decision process.
- Mitigation options were limited due to multiple uses or available technology.
- Solution alternatives were multi-attribute and/or uncertainty existed in performance, cost, or schedule projections.

Impact study results frequently lack the detail or resolution necessary to clearly identify and quantify the projected adverse impacts in terms that can be used to develop ecologically effective and appropriately scaled mitigation plans. This problem, combined with the involvement of multiple groups or agencies with differing priorities and responsibilities, makes it difficult to reach a consensus on functional mitigation objectives. This situation is further compounded by the fact that, despite the number of past mitigation projects, the site- specific nature of the problem causes uncertainty in the assessment of mitigation performance, cost, or schedule.

Current Habitat Enhancement Options

Common habitat compensation options available for aquatic mitigation include wetland restoration, artificial wetland creation using dredged material, and the planting of submerged aquatic vegetation. Less frequently proposed alternatives include channel modifications to improve circulation, excavation of uplands to create wetlands, or anadromous fish passage improvement or stocking. However, the alternatives most appropriate for in-kind mitigation in ports and harbors are frequently limited due to lack of land or shallow areas available for wetland creation/restoration and water quality conditions which limits SAV success. In addition, the recurring maintenance costs associated with these common compensation measures can be significant if these approaches are applied in areas poorly suited to their application.

Wetland creation and restoration have been successfully applied to a number of port and coastal development projects. These methods are appropriate when wetland areas are impacted or lost, and where suitable land or water areas are available and reliable functional performance can be expected. SAV plantings has also proven effective in selected projects. Likewise, kelp planting in the port of Los Angeles has been successful and effective (Rice, 1983). This approach is appropriate when SAV areas are affected and where water quality and site conditions suggest that this approach will result in long-term habitat production. However, many port areas are fully developed and multiple users compete for any remaining shore areas. Many sites suitable for wetland creation are limited by use conflicts that minimize opportunities for on-site habitat compensation. The water quality and turbidity conditions in many port areas are also less than ideal for SAV success. Although water quality is improving in many areas, current conditions often limit the long-term success for SAV planting (Ord, 1985).

Prefabricated Artificial Reef Technology

In many cases, the habitat impacted by to port expansion includes shallow water areas lost due to land reclamation, creation of artificial islands, or dredging. Prefabricated designed artificial reefs have been suggested as tools for such marine and estuarine mitigation (Aquabio, 1980, Sheehy,1982; Sheehy and Vik, 1983) and specifically recommended for port and harbor applications (Gatton, 1983; Sheehy and Vik, 1984). Prefabricated artificial reefs were initially introduced in the U.S. (Sheehy, 1976, Aquabio, 1978) as a means of enhancing lobster populations. Habitat modules designed to meet species and site specific conditions were mass produced to expand areas suitable for lobster occupancy. As the result of a technology transfer effort (Sheehy, 1979), a broader base of Japanese and Taiwanese (R.O.C.) technology was introduced (Aquabio, 1982), field evaluated (Aquabio, 1983), and modified for American applications (Sheehy, in press). This transferred technology included a variety of reef modules that are potentially suitable for fish, shellfish, and macroalgae habitat enhancement.

Prefabricated designed artificial reefs have a number of advantages as mitigation tools:

- No requirement for land acquisition.
- Flexible design to meet site-specific conditions and target species or community requirements.
- Predictable cost and reliable performance.
- Effective use of limited available space.

These features make reef modules very suitable for port and harbor applications where available space is limited, sites conditions are restrictive, and modifications may be necessary to meet specific target species or life stage requirements. Existing prefabricated reef designs can be modified to meet site and functional biological requirements in a cost-effective manner. Reef modules can be tailored to provide maximum effectiveness per unit of bottom area available and can easily be applied in a phased manner to meet staged development or mitigation banking requirements.

A distinction must be made between prefabricated mitigation reefs and the traditional scrap material recreational fishing reefs that have been built for some time along the U.S. coasts (Sheehy and Vik, 1984). The purpose of a mitigation reef is habitat compensation rather than the direct improvement of recreational fishing. The application objective of a mitigation reef is to increase the carrying capacity of an area for communities and species impacted by the proposed project. This differs from from the objectives of recreational fishing reefs, which are placed to improve catch per unit effort of top predator species and, in many areas, to dispose of solid waste material. Due to the differences in goals and objectives, mitigation reefs generally employ the best available technology to conserve and preserve natural resources, whereas recreational reefs generally use materials of opportunity and are managed to maximize either catch or disposal efficiency.

Artificial reefs function in a habitat compensation mode by directly replacing communities, nutrient resources, or critical habitat functions lost due to project impacts. In many ports and harbors, benthic resources are lost due to burial or contamination, while fish and shellfish habitat and other nutrient resources are lost due to filling of marsh, SAV, and open water habitat. Reefs can perform some of these functions through the provision of hard substrate suitable for epifaunal colonization, provision of cover and concealment habitat required by some species or life stages, and alteration of local circulation patterns to concentrate nutrient sources. However, reefs are clearly not a means of in-kind replacement for all the functions of wetlands or SAV. Reef applications should be integrated into comprehensive mitigation plans to provide the best combination of functional features needed to adequately compensate for project impacts.

The provision of additional hard substrate that is elevated off the bottom can substantially increase epifaunal community development, and directly and indirectly provide significant food resources for fish and critical substrate for other species such as the oyster. The three-dimensional aspect of these mitigation reef modules can provide a large available surface area per unit of bottom covered, depending on the design. Resulting increases in epifaunal biomass can contribute to fish food resources lost due to burial or contamination of hard and soft bottom substrate.

Cover and concealment is essential to a number of species, such as lobsters (*Homarus americanus*) and Tautog (*Tautog onitis*) that are generally not found resident in an area without adequate shelter or fixed references. Other species require substrate or certain habitat types for ovideposition or spawning. Juveniles of many species indicate a preference for the shelter and food provided by SAV beds. Some of these requirements can be met with appropriately designed reef structures that can provide this type of habitat until such time as water quality permits effective replanting or natural reestablishment of SAV.

Prefabricated structures are also designed to alter circulation patterns. Those units that are suitable for mitigation applications in ports generally create complex turbulent flow patterns effective in concentrating plankton and detritus. This concentrates plankton for species or life stages that depend on these resources and can also concentrate detritus that may contribute to increased local benthic productivity.

Conceptual Mitigation Planning Process

The approach to mitigation analysis that was developed from our past experience is based on the results of both an impact assessment as well as a conflict assessment. The impact assessment characterizes and quantifies the extent and duration of projected functional ecological losses for the proposed project. The conflict assessment identifies the potential conflict issues that may arise as a result of actual losses in habitat or alternate use opportunity. It may also include issues that may not be directly based on natural resource loss, such as fishing or boating access. The action options and solution preferences for each possible participating group or agency are projected for use in predicting stable solutions.

Based on these inputs, the mitigation analysis used to develop decision support includes, as a minimum:

- Determination of functional requirements.
- Specification of clear mitigation objectives.
- Review of alternatives.
- Selection of cost-effective mitigation options.
- Development of an integrated mitigation plan.
- Determination of monitoring and evaluation requirements.

This information is used to develop a mitigation plan that is provided to the project decision makers in the form of decision support information and guidance. Since most port development decisions are made only after extensive interagency coordination, this information should be presented in a form that includes an explanation of the biological, engineering, and economic aspects of the project. Mitigation proposals need to clearly demonstrate that significant long-term environmental benefits for living resources will be achieved, that mitigation technology is reasonably available to the applicant, and that mitigation is both feasible and practicable.

Case Study: Wilmington Harbor South, Delaware

A project to maintain authorized channel depths in the Wilmington Harbor Federal Navigation channel adjacent to the Wilmington Marine Terminal and to leave open opportunities for on-site port relocation and expansion resulted in a plan to fill 326 acres. This area included 87 acres of uplands, 12 acres of vegetated wetlands, 85 acres of intertidal mudflat, and 142 acres of shallow water habitat. The mitigation plan included a broad range of mitigation measures including vegetated wetlands, and operational controls on construction impacts to facilitate the passage of migrating anadromous fish. To address the loss of shallow water habitat, the conceptual mitigation plan called for the use of artificial reefs.

Aquabio applied a systems analysis approach (Aquabio, 1988) to address some of the multi-attribute problems associated with the selection of artificial reef sites and designs, conducted a feasibility study, and prepared recommendations and a preliminary cost estimate. The systems approach provided a logical method of analysis, defined and recorded the decision logic, ensured that alternatives were adequately considered, and helped clarify communications with decision makers and interested parties.

Potential reefs sites were selected based on a hierarchical screening approach that included practical considerations, substrate, oceanographic conditions, biological factors, and access by recreational fishermen. The latter concern was in response to secondary objectives associated with providing additional recreational fishing opportunities. The recommended and alternate artificial reef areas are shown in Figure 1. The area near Brown's Shoal was selected as the most suitable site given the derived functional objectives and available site physical and biological data as well as information on target species requirements and preferences. A multiple attribute decision making method was used to evaluate potential reef areas according to criteria that were weighted in accordance with past performance experience.

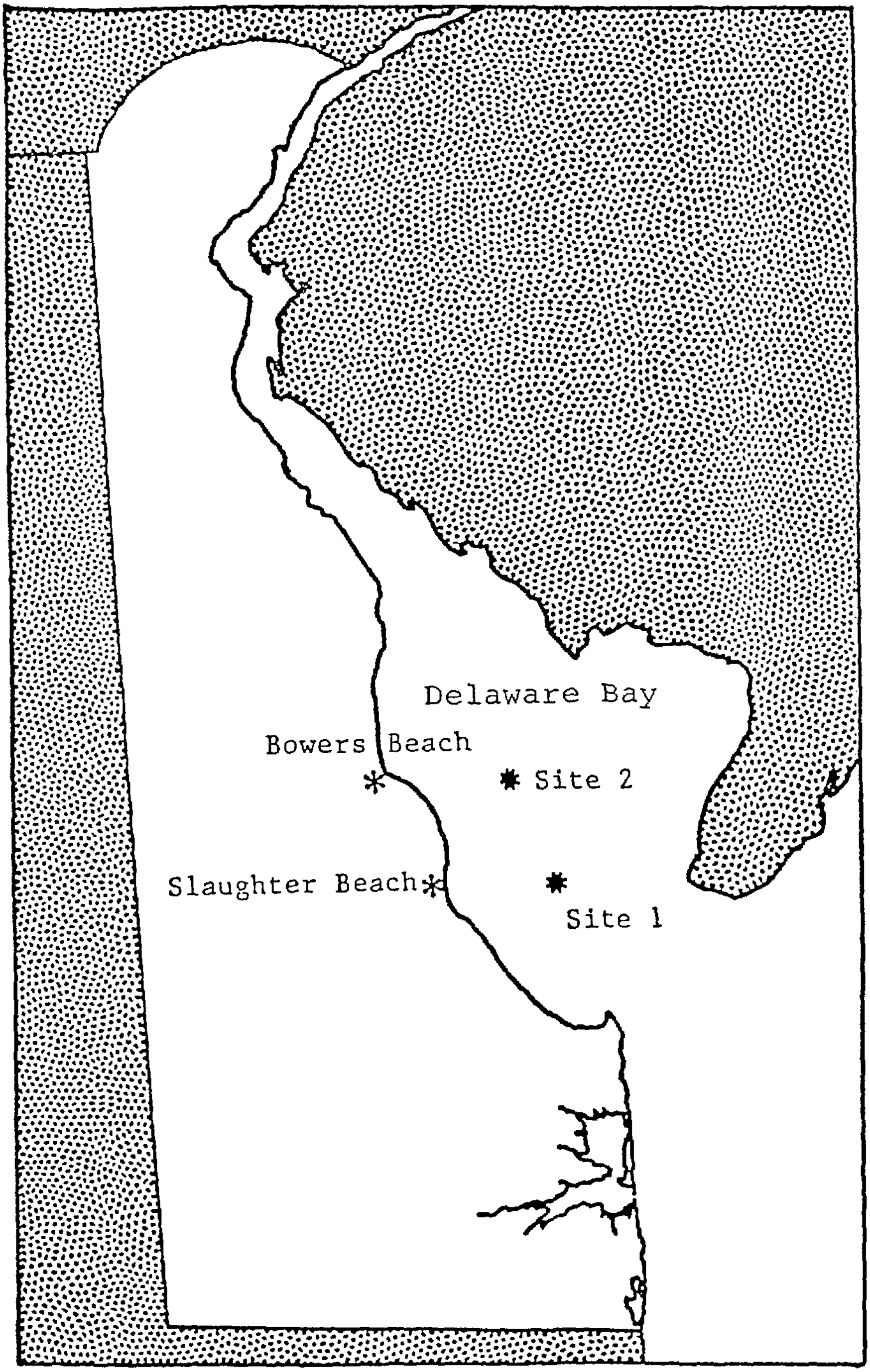


Figure 1. Selected Artificial Reef Areas in Delaware Bay.

The potential reef module designs that were screened and reviewed in detail for this application were generally characterized as having proven long-term structural integrity, were fabricated from non-leaching materials, were stable at the proposed sites, created turbulent flow patterns, and possessed extensive "effective" surface area and habitat complexity. "Effective" surface area, in this context, refers to hard substrate exposed to adequate circulation to produce an abundant epifaunal community (not interior surfaces or areas exposed to sand scour). All designs recommended by Aquabio were proven and tested, rather than developmental, reef modules in order to ensure reliable functional performance, permit compliance, and predictable life expectancy and cost.

The three reef modules initially recommended as suitable for the proposed mitigation application in Delaware Bay are illustrated in Figures 2 to 4. These reef modules were all originally designed and fully tested in Japan (Aquabio, 1982) and adapted for American mitigation applications.

The module illustrated in Figure 2 is fabricated from filament wound fiberglass reinforced plastic (FRP), ballasted with reinforced concrete, and offers a flexible design that was modified to suit the site conditions. This reef type was originally introduced in the U.S. by Aquabio in 1980 (Aquabio, 1981), was field tested at three sites off Florida (Aquabio, 1982), and was modified for estuarine applications (Aquabio, 1984). This is a fully operational design with more than 10,000 units deployed worldwide, and has an excellent performance history and proven reliability.

The second module, illustrated in Figure 3, is fabricated from composite plastic components that are anchored on a reinforced concrete base. This module is also flexible in design, has considerable "effective" surface area, and a broad bearing surface. The third module shown in Figure 4 is fabricated totally from reinforced concrete sections. This module is somewhat more massive but has excellent stability characteristics for low wave energy areas and provides complex shelter areas with adequate "effective" surface area.

Each of these designs were judged suitable for potential application, given the available information of site conditions and the combination of biological performance attributes agreed to by the interagency group established to guide the mitigation effort. Implicit and explicit trade-offs were made in the selection process as a result of the multiple and often conflicting objectives (habitat compensation and recreational fishing) and attributes (effective surface area and stability). Final selection of the reef module type will reflect the results of further data acquisition on the sites, including substrate conditions and bottom current data, as well as cost.

Conclusions

Continued development and redevelopment pressure in ports and harbors will require mitigation in order to compensate for habitat losses and resolve fishery related conflicts. Prefabricated designed reefs are potential tools for habitat compensation and conflict resolution in port and harbor areas. Their design flexibility permits them to be tailored to site- specific conditions and mitigation objectives, and their prefabricated designs permit cost-effective applications that can be phased with development progress or mitigation banking requirements.

The selection, configuration, and location of such structure is site-specific and requires a concise statement of functional mitigation objectives and constraints. The selection of sites and reef designs is a complex problem with project-specific con-

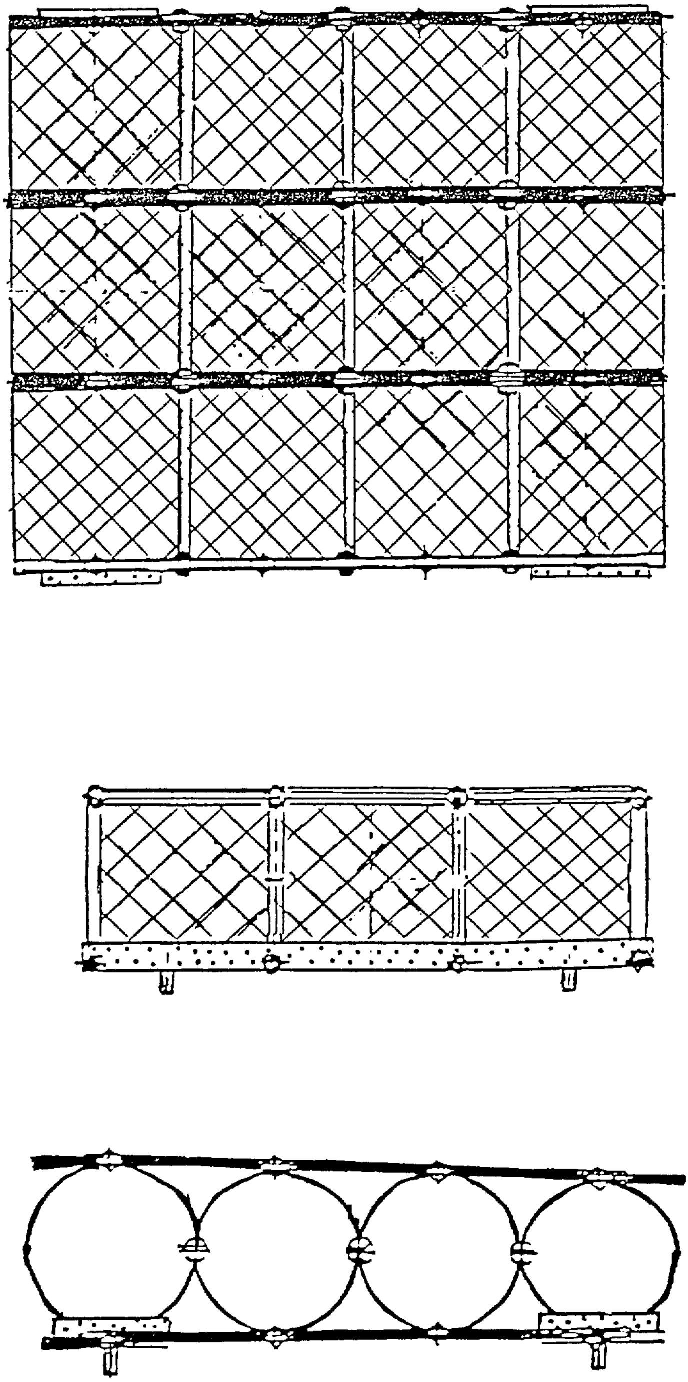
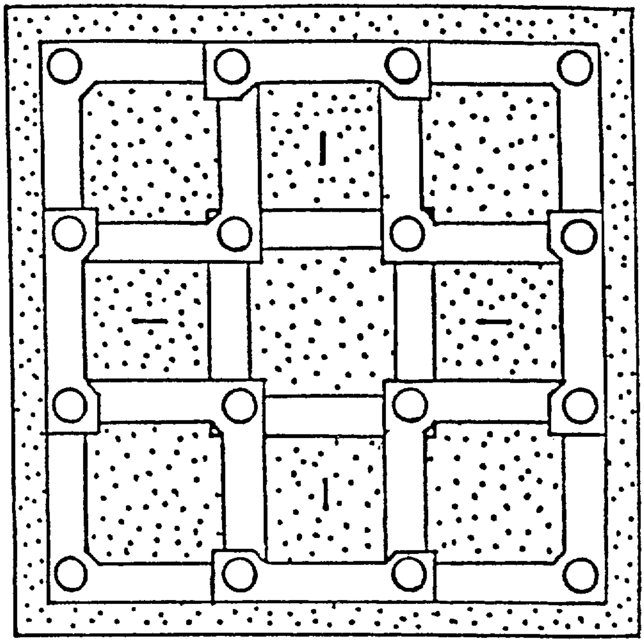


Figure 2. FRP Reef Module sketched in plane, side, and front views.
Dimensions: 7.1 (1) x 6.8 (w) x 2.0 (h) meters.



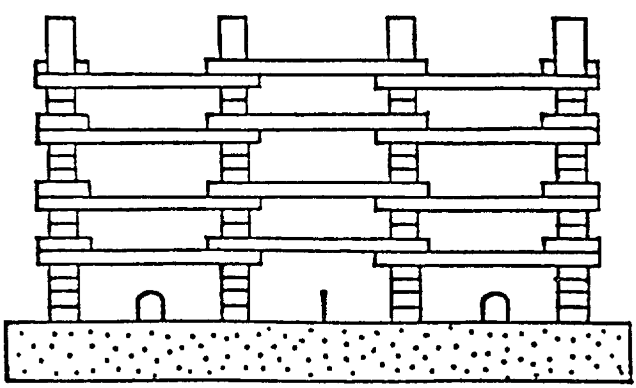


Figure 3. Composite Shelter Reef sketched in plane, side, and front views.
Dimensions: 3.0 (1) x 3.0 (w) x 1.8 (h) meters.

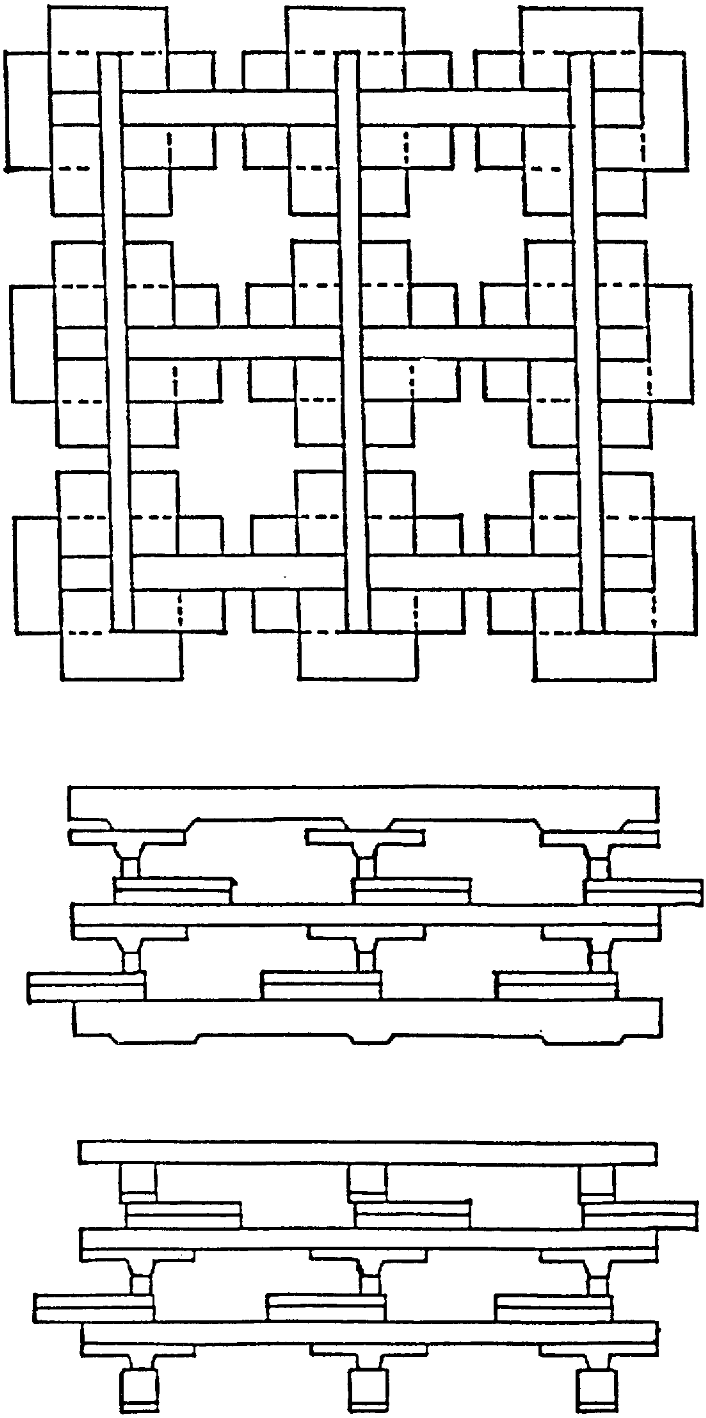


Figure 4. Terrace Reef sketched in plane, side, and front views.
Dimensions: 5.8 (l) x 5.8 (w) x 2.3 (h) meters.

straints, site conditions, and target species, life stages, or communities. The reef designer must consider all of the factors involved to select modules and a reef configuration consistent with the mitigation objectives. Proven and tested rather than developmental designs are recommended for major mitigation projects to provide the reliability needed for these applications.

Prefabricated reefs are tools for mitigation and should be used only when and where appropriate. The availability of such tools should not be used to replace sound environmental management practices. Reefs are best suited to applications where open water habitat is lost or where reef functions can partially substitute for wetland or SAV habitat functions when these alternative are not available due to site constraints.

References

Aquabio, Inc. 1978. An evaluation of artificial reefs constructed from prefabricated unit shelters designed for the American lobster (*Homarus americanus*). Aquabio, Inc. 78-TN-04.

Aquabio, Inc. 1980. Artificial reefs as a means of marine mitigation and habitat improvement in Southern California. Aquabio 80-TT-564.

Aquabio, Inc. 1982. *Japanese Artificial Reef Technology: Translations of selected Japanese Literature and An Evaluation of Potential Applications in the U.S.* Sheehy, D.J. and S.F. Vik, eds., Aquabio Technical Report 604. 380 pages. Aquabio, Inc. P.O. Box 4130, Annapolis, MD 21403.

Aquabio, Inc. 1988. Mitigation planning for port development. In press.

Gatton, R, D. 1983. The question of mitigation. In: Proceedings of the Third Symposium in Coastal and Ocean Management. Pages 1105-1119. O.T. Magoon and H. Converse, eds. American Society of Civil Engineers.

Orth, R.J. 1985. Submerged aquatic vegetation in the Chesapeake Bay: Value, Trends, and Management. In: Wetlands of the Chesapeake. Proceedings of a conference held April 9-11, 1985:84-95.

Rice, D. 1983. Los Angeles harbor Kelp Transplant Report. In: Proceedings of the Third Symposium on Coastal and Ocean Management. Pages 1082-1089. O.T. Magoon and H. Converse, eds. American Society of Civil Engineers.

Sheehy, D.J. 1976. Utilization of artificial shelters by the American lobster (*Homarus americanus*). J. Fish. Res. Bd. Canada 33(7):1615-1622.

Sheehy, D.J. 1979. Fisheries Development: Japan. Water Spectrum: Winter 1979:1-9.

Sheehy, D.J. 1982. The construction and testing of designed and prefabricated Japanese artificial reefs in the U.S. ICES, Mar. Env. Qual. Comm. CM 1982/E:63.

Sheehy, D.J. and S.F. Vik. 1983. Recent advances in artificial reef technology. In: Proceedings of Oceans '83. Vol. II, 957- 960. IEEE.

Sheehy, D.J. and S.F. Vik. 1984. The application of designed artificial reefs in coastal mitigation/compensation and fisheries development projects. In: Proceedings of the Ninth Annual Conference of the Coastal Society, 331-338.

PREDICTION OF FATE AND EFFECTS OF WASTEWATER SOLIDS DISCHARGED TO MASSACHUSETTS BAY COASTAL WATERS

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Introduction

Boston Harbor is currently being degraded by the wastewater from 43 cities and towns served by the Massachusetts Water Resources Authority MWRA. At present the MWRA's two existing treatment plants at Nut Island and Deer Island service 1.9 million people. During an average day of operation, MWRA's two existing wastewater treatment plants discharge 450 million gallons of inadequately treated sewage and 70 tons of digested sludge (MWRA, 1987). In order to remedy this problem, a new wastewater treatment facility is being constructed on Deer Island. An essential component of this wastewater treatment facility is an effluent outfall system to convey treated wastewater to an ocean discharge location. Beginning in 1995 the new treatment facilities will begin discharging effluent from the primary treatment plant for five years until full secondary facilities come on line in approximately 1999 (MWRA, 1987). The main focus of this paper is fate and effects of the wastewater solids discharged into coastal waters under both primary and secondary treatment and the use of these predictions in siting the effluent outfall. The analysis presented in this paper was conducted for U.S. EPA region I by Metcalf & Eddy in Support of the Boston Harbor Wastewater conveyance system Supplemental EIS (U.S.EPA, 1988)

Under primary treatment approximately 60 percent of the solids will be removed from the wastewater influent resulting in an average effluent load of 1,150 grams solids/second. Under secondary treatment approximately 85 percent of the solids will be removed resulting in a load of 363 grams solids/sec.

Approach

Initially several proposed outfall locations were screened using pre-established criteria resulting in 3 alternative sites for detailed evaluation (U.S. EPA, 1988; Figure 1). The predicted environmental impacts of both an interim primary and secondary discharge at each of these sites were then assessed for both stratified and non-stratified water column conditions. The type of impacts assessed fall into two general categories: water quality and sediment quality.

For water quality, predictions were made at each alternative outfall location for concentrations of toxic compounds, nutrient enrichment and dissolved oxygen deficits during both primary and secondary treated discharges using hydrodynamic and water quality models. In order to assess the extent of associated ecosystem impacts for these parameters, predicted concentrations were compared to pre-established criteria or standards. Predicted concentrations of toxic compounds were compared to U.S. EPA Water Quality Criteria to determine their acute and chronic effects on aquatic life while nutrient enrichment was compared to enrichment levels resulting in changed or degraded conditions in several experimental ecological studies. Dissolved oxygen deficits were compare to Massachusetts Water Quality Standards (of not less than 6 mg/1 for class SA waters).

Sediment quality was evaluated by assessing sediment organic enrichment, sediment toxics accumulation and the effects of sediments on water column dissolved oxygen during sediment resuspension events. Toxics tend to build up in the sediments since they are not broken down by organisms while organic carbon is respired by organisms. Oxygen deficits result from resuspension of organic sediments exerting a BOD in the water column. These events occur during large storms and in general are only a few hours in duration.

The first step in the assessment of sediment quality was to model sediment deposition. The farfield modelling used in this assessment simulates the processes taking place over large distances(km) and time scales (hours to weeks) after rapid dilution of the wastewater in the nearfield or mixing zone. The hydrodynamic model TEA (Tidal embayment analysis) and its companion water quality transport model ELA (Eulerian-Lagrangian Analysis) were used for farfield modeling of this study. Detailed descriptions of TEA and ELA are given in Baptista et al. (1984), Westerink et al. (1985), Kossik et al. (1986). These two- dimensional (vertically-averaged) finite element models account for the location, magnitude and configuration of alternatvee effluent discharges, as well as the effects of spacial and temporal variations in tidal and residual circulation, turbulent diffusion and constituent decay and sedimentation. These models permit detailed resolution of complex coastal geometries as well as refined grid resolution in areas of special interest. These models were applied to both stratified and non-stratified conditions in Massachusetts Bay. Stratified conditions occur during summer and generally result in the effluent plume being trapped below the pycnocline. Only one layer was simulated during stratified conditions, assuming the plume was trapped in the lower layer below the pycnocline.

Sediment deposition rates were determined for primary and secondary treated effluent discharges under both stratified and non-stratified average net drift conditions. The deposition of solids is controlled by their fall velocity (w) and can be simulated as a first order decay of coefficient $K = w/H$, where H which will be distributed approximately evenly over the water depth due to ambient turbulence.

The fall velocity is a function of the particle size, ambient turbulence and suspended solids concentration. For this analysis, three fall velocities were used: 0.1, 0.01 and 0.001 cm/sec. It was assumed that solids with lower fall velocities effectively do not settle (Table 1). Figures 2 and 3 show an example of predicted sediment deposition rates at alternative outfall Site 4 during non-stratified and stratified conditions respectively.

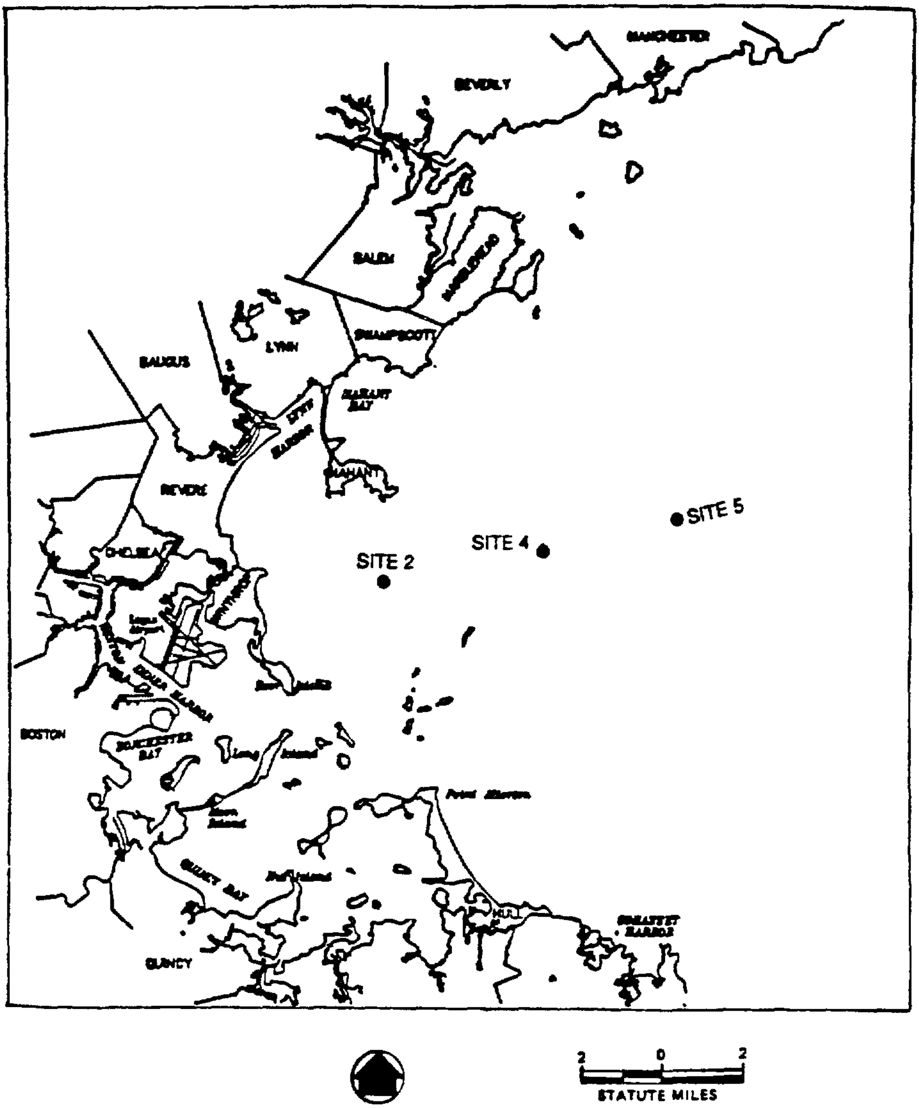

Figure 1. Alternative Outfall Diffuser Locations

TABLE 1. DISTRIBUTION OF SOLIDS FALL VELOCITIES

Fall Velocity (cm/sec)	Primary Treatment	Secondary Treatment
0.1	5%	0%
0.01	20%	16%
0.001	35%	34%
does not settle	40%	50%

Sediment Organic Enrichment

Historically, organic enrichment from wastewater discharges has been observed to have the greatest impact on benthic communities (Swartz et al., 1986; Pearson and Rosenberg, 1978; Mearns and Word, 1982; Pearson, 1982; Bascom et al., 1978; Poore and Kudenov, 1978; Oviatt et al., 1987; Maughan, 1986). Several studies have found macrobenthic infaunal communities to respond in a consistent pattern to changes in the level of sediment organic enrichment (Pearson and Rosenberg, 1978; Bascom et al., 1978). In general, benthic communities in the immediate vicinity of a source of major organic enrichment contain either no macrofauna or are dominated by only a few pollution-tolerant opportunistic species that occur in high numbers. These types of communities are considered to be degraded. With increased distance from the source of enrichment this degraded community is replaced by a community with higher species richness and biomass that gradually changes to a community characteristic of unpolluted environment. These communities with higher species richness and biomass are considered to be changed communities (Pearson and Rosenberg, 1978; Swartz, 1986).

In order to assess impacts or changes in community structure due to organic enrichment from the future MWRA discharge, rates of organic sediment enrichment have been predicted at the alternative outfall locations. These rates were predicted from the modeled sediment deposition rates presented previously assuming organic carbon comprises 40 percent of the effluent particulates (Metcalf & Eddy, 1979). These modeled rates were then compared to reported field studies in the New York bight (O'Conner et al., 1983; Gunnerson et al., 1982) and Southern California (Herring and Abati, 1979; Mearns and Word, 1982) as well as mesocosm experiments (Maughan, 1986). Deposition rates causing no benthic change have been estimated between 0 and 0.13 g C/m2/day while areas of degraded benthos have organic deposition rates 1.5 g C/m2/day to approximately 5.0 g C/m2/day. For this analysis it was assumed that deposition of 1.5 gC/m2/day would cause degraded benthic conditions while deposition below 0.1 gC/m2/day would cause no change in community structure. Rates between these two values are assumed to cause changed conditions.

In order to compare alternative outfall sites, the areal extent of predicted degraded benthic communities and changed benthic communities were determined for each site under both stratified and non-stratified conditions. Figure 4 shows the extent of degraded and changed benthic communities under stratified conditions with primary treatment. The extent of the impacts decreases with increasing distance from shore due to the increased dilution. Figure 5 show the affected areas for all sites under stratified conditions with secondary treatment. No degraded conditions are expected with secondary treatment and again, the area affected decreases with increasing distance from shore.

Sediment Toxics Accumulation

The nest parameter evaluated in the impact prediction of an outfall siting was the accumulation of toxic compounds in the sediments. Toxic substances associated with effluent particulates can accumulate in bottom sediments and have adverse affects on the associated biota. Very little quantitative information is available on concentrations of toxics in the sediments and their associated effects on the benthos and higher trophic levels. There are also no established criteria to evaluate

Figure 2. Sediment Deposition Rates (G/M^2/Day) for Primary Discharge at Site 4 Non-stratified Conditions

Figure 3. Sediment Deposition Rates (G/M^2/Day) for Primary Discharge at Site 4 Stratified Conditions

sediment acute and chronic toxicity. Even at a given concentration, toxicity of a given constituent may vary between sediment types due to differences in the bioavailability of the constituent (Windom et al., 1982). Realizing these limitations, an attempt was made to predict and quantify impacts associated with toxics accumulation in the sediments in order to compare relative impacts among sites.

First, a model was developed to predict concentrations of various compounds in the sediments (Fig 6). Three sources of toxics were considered in this model:

1) deposition of chemicals associated with effluent particles

2) deposition of chemicals associated with background suspended solids settling assuming a background SS deposition rate of 0.5 mm/y and

3) mixing of deposited chemicals with existing bottom sediments through bioturbation

Simulation of toxics accumulation were done at each site for non- stratified conditions for primary and secondary treatment for periods of 6 months 1 year and 5 years. In addition, predictions of sediment concentrations were made for each 6 month case.

The next step in the process was to compare these predicted concentration to values found in literature to have adverse affects to marine organisms. Studies used in these comparisons include Swartz et al., 1986; Perez et al., 1983; Reed et al., 1984; Peddicord, 1980; Rubenstein et al., 1984; Calabrese et al., 1982 and Oviatt et al., 1987. Literature information was not readily available for all compounds present on the particulates. The areal extent of potential toxics effects was then determined for all constituents whose maximum predicted concentration was greater than known adverse affects levles.

Table 2 shows the areal extent of adverse impacts of two compounds whose predicted concentrations were shown to have adverse affects in literature. No adverse affects are predicted to occur during secondary treatment; while under primary treatment, the extent of the impact decreases with increasing distance from shore and increases over time. It should be noted that the model of sediments for secondary effluent took into account the elevated levels of toxics resulting from 5 years of interim primary effluent discharge. The Secondary treated particulates serve to dilute the sediments.

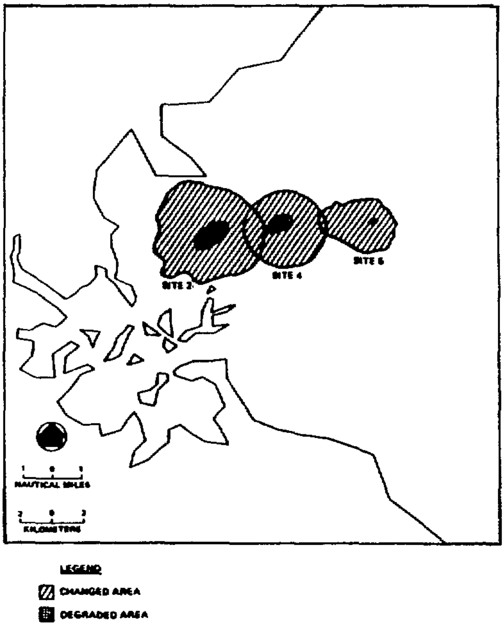

Figure 4. Areas of Predicted Changed and Degraded Benthic Communities due to Organic Enrichment Under Stratified Conditions with Primary Treatment for all Sites

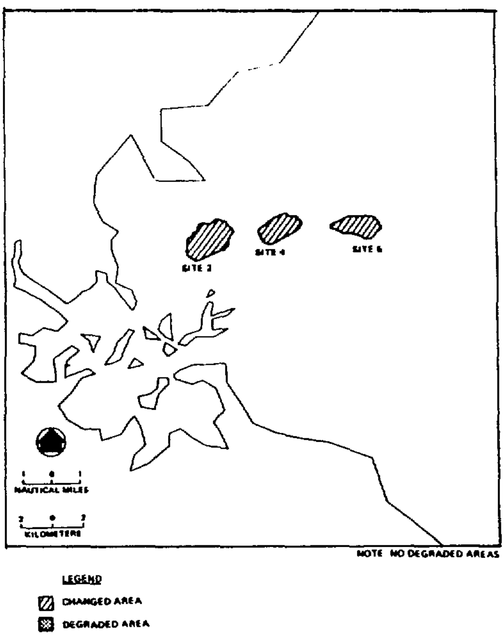

Figure 5. Areas of Predicted Changed and Degraded Benthic Communities due to Organic Enrichment Under Stratified Conditions with Secondary Treatment for all Sites

TABLE 2. AREAL EXTENT (KM2) OF PREDICTED SEDIMENT TOXICITY

Compound	Primary Treatment Site 2	Primary Treatment Site 4	Primary Treatment Site 5	Secondary Treatment Site 2	Secondary Treatment Site 4	Secondary Treatment Site 5
Bis(ethle-hexyl) Phthalate						
6 months stratified	0	0	0	0	0	0
5 years non-stratified	2.8	2.4	1.6	0	0	0
DDT						
6 months stratified	0	0	0	0	0	0
5 years non-stratified	1.4	0.9	0	0	0	0

Dissolved Oxygen (DO) Deficits

Dissolved oxygen deficits were also evaluated in this analysis. DO deficits were modelled for both stratified and non-stratified conditions under average net drift and no net drift conditions using the dissolved BOD. Several resuspension events were also modelled by adding the BOD of resuspended deposited sediments to the daily input of dissolved BOD.

The greatest DO deficit or smallest resultant DO occur once a year during the fall stratified conditions. This event was modeled using the following combinations of events:

> No resuspension event during 90 days in the summer ended by a 10 day period of no net drift, followed by a theoretical early fall storm.

Table 3 shows minimum water column DO concentrations under various condition.

TABLE 3. MINIMUM WATER COLUMN DO CONCENTRATIONS DURING RESUSPENSION EVENT (mg/l)

Treatment	Stratification	Net Drift	Site 2	Site 4	Site 5
Primary	Unstratified*	Average	6.5	6.7	7.2
		Worst	6.5	6.5	6.8
	Stratified*	Average	2.3	5.3	6.8
		Worst	2.2	5.0	6.2
	Fall**		5.0	5.4	5.7
Secondary	Unstratified*	Average	7.3	7.5	7.8
		Worst	7.4	7.4	7.6
	Stratified*	Average	5.9	7.1	7.7
		Worst	5.9	7.0	7.4
	Fall**		6.2	6.3	6.4

*Equal to ambient DO (8 mg/l) minus maximum farfield DO deficit minus resuspension oxygen demand

**Equal to ambient DO (6.5 mg/l) minus resuspension oxygen demand

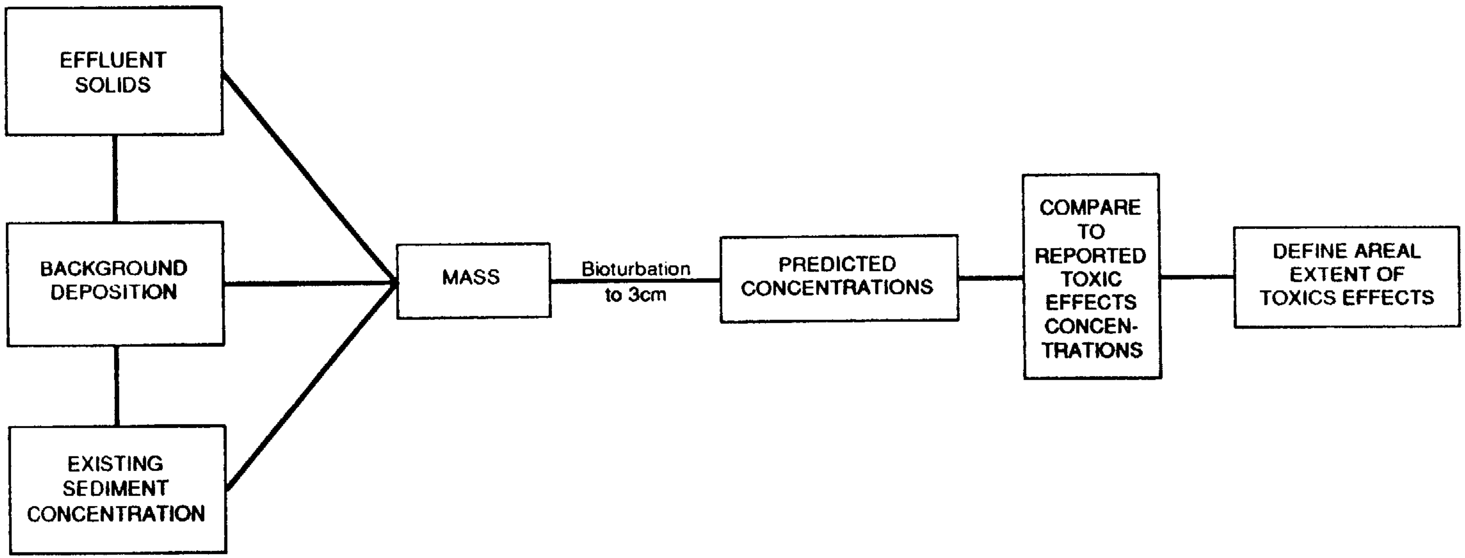

Figure 6. Concentrations of Toxic Compounds in Sediments

The results show that the Massachusetts water quality standard of 6 mg/l DO would not be violated at any site for secondary discharge except for site 2 by 0.1 mg/l. For primary discharge, the standard would be violated during resuspension events for both stratified and non stratified conditions. At site 4, the standard would be violated during resuspension events occurring while the water column is stratified. The violations during resuspension events would be over a depth of approximately 10 meters form the bottom. During fall DO drops to 5.7 at site 5.

Summary

Assessment of the effects of the discharge of waste water solids on sediment quality and associated ecosystem effects was based on analysis of impacts related to organic enrichment, sediment toxicity and DO deficits associated with resuspension events.

Based on this evaluation, site 2 is not a preferred discharge site due to potential long term impacts associated with

- the extent of the predicted changed benthic community associated with organic enrichment,
- the extent of potential sediment toxicity and associated ecological effects and the
- degree of frequent occurrence of DO violations

Sites 4 and 5 show little difference under long-term secondary treatment and both are acceptable site for a secondary treated wastewater discharge. In addition the interim discharge of primary effluent the predicted impacts for sites 4 and 5 are similar and not predicted to be severe or irreversible.

References

Baptista, A.M., E.E. Adams, K.D. Stolzenbach, 1984. The solution of the 2-D unsteady convection-diffusion equation by the combined use of the FE method and the method of characteristics. Proceedings, 5th International Conference on Finite Elements in Water Resources. University of Vermont. Burlington, VT.

Bascom, W., A.L. Mearns, and J.Q. World, 1978. Establishing Boundaries Between Normal, Changed and Degraded Areas, In: Bascom, W., (ed.), Coastal Water Research Project, 1978 Annual Report, El Sequndo. California. Pp. 81-84.

Calabrese, A., E. Gould, and F.P. Thurberg, 1982. Effects of Toxic Metals in Marine Animals of the New York Bight: Some Laboratory Observations, In: Mayer, G.F. (ed.), Ecological Stress and the New York Bight: Science and Management. Estuarine Research Federation. Columbia, South Carolina. Pp. 281-298.

Gunnerson, C.G., R.T. Adamski, P.W. Anderson, R.S. Dewling, D.A. Julius, G.S. Keleppel, D.W. Lear, A.J. Mearns, J.T. Miller, E.P. Meyers, J.T. Roswell, C. Shoeder, C.J. Segar, 1982. Management of Domestic Wastes, In: Mayer, G.F. (ed.), Ecological Stress and the New York Bight: Science and Management. Estuarine Research Foundation. Columbia, South Carolina. Pp. 91-112.

Herring, R.E. and A.L. Abati, 1979. Effluent Particle Dispersion, In: Bascom, W. (ed.), Coastal Water Research Project Annual Report, 1978. Southern California Coastal Water Research Project, El Sequndo, CA. Pp. 113-125.

Kossick, R.F., P.M. Gschwend, and E.E. Adams, 1986. Tracing and Modelling of Pollution Transport in Boston Harbor. Sea Grant Report No. 86-016. MIT, Cambridge, MA.

MWRA (Massachusetts Water Resources Authority), 1987. Deer Island Secondary Treatment Facilities Plan.

Maughan, J.T., 1986. Relationship between Macrobentic Infauna and Organic Carbon. Ph.D. Thesis. University of Rhode Island, Graduate School of Oceanography. Narragansett, RI.

Mearns, A.J. and J.Q. Word, 1982. Forecasting Effects of Sewage Solids on Benthic Communities. In: Mayer, G.F. (ed.), Ecological Stress and the New York Bight: Science and Management. Estuarine Research Federation. Columbia, South Carolina. Pp. 495-512.

Metcalf & Eddy, 1979. Wastewater Engineering: Treatment, Disposal, Reuse. Second Edition. McGraw Hill, New York.

O'Conner, J.P., A.O. Kubo, M.A. Champ, and P.K. Parker, 1983. Projected Consequences of Dumping Sewage Sludge at a Deep Ocean Site near New York Bight. Can. J. Fish Aquat. Sci. 40 (suppl.):228-241.

Oviatt, C.A., J.G. Quinn, J.T. Maughan, J.T. Ellis, B.K. Sullivan, J.N. Gearing, C.D. Hunt, P.A. Sampou, and J.S. Latimer, 1987. Fate and Effects of Sewage Sludge in the Coastal Marine Environment: A Mesocosm Experiment. Mar. Ecol. Prog. Ser. 41:187- 203.

Pearson, T.H. and R. Rosenberg, 1978. Macrobenthic Succession in Relation to Organic Enrichment and Pollution of the Marine Environment. Oceanog. Mar. Biol. Ann. Rev 16:229-311.

Peddicord, R.K., 1980. Direct Effects of Suspended Sediments on Aquatic Organisms, In: Baker, R.B. (ed.), Contaminants and Sediments Vol. 1: Fate and Transport Case Studies, Modelling, Toxicity. Ann Arbor Science, Ann Arbor, Michigan. Pp. 501-536.

Perez, K.T., E.W. Davey, N.F. Lackie, G.E. Morrison, P.G. Murphy, A.E. Soper, and D.L. Winslow, 1983. Environmental Assessment of a Phthalate Ester, Di(2-ethylhexyl)phthalate (DEHP), Derived from a Marine Microcosm, In: Bishop, W.E., R.D. Carwell, B.B. Heidolph (eds.), Aquatic Toxicology and Hazard Assessment: Sixth Symposium. ASTM STP 802. Pp. 190-191.

Poore, G.C.B. and J.D. Kudenov, 1978. Benthos Around an Outfall of the Werrebee Sewage - Treatment Farm, Port Phillip Bay, Victoria, Australia. Aust. J. Mari. Freshwater Res. 29:157-167.

Reed, M., K. Jayko, T. Isaji, and J. Rosen, 1984. Ocean Risk Assessment Model System (ORAMS): Development and Preliminary Applications. A Report for U.S. EPA Contract No. 68-016621. Pp 89. Applied Science Associates, Inc., Narragansett, RI.

Rubenstein, N.I., W.T. Gilliam, and N.R. Gregory, 1984. Dietary Accumulation of PCBs form a Contaminated Sediment Source by a Demersal Fish (Leiostomus xanthhurus). Aquatic Toxicology 5:311- 342.

Swartz, R.C., F.A. Cole, D.W. Schultz and W.A. DeBen, 1986. Ecological Changes in the Southern California Bight near a large Sewage Outfall: Benthic Conditions in 1980 and 1983. Mar. Ecol. Prog. Ser. 31:1-13.

U.S. EPA, 1988. Boston Harbor Wastewater Conveyance System Supplemental Environmental Impact Statement.

Westerink, J.J., K.D. Stolzenbach, and J.J. Conner, 1985. A Frequency Domain Finite Element Model for Tidal Circulation. Report No. 95-006. Energy Laboratory. MIT, Cambridge, MA.

HARBOR USES, WATER QUALITY AND USE ATTAINABILITY

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Introduction

Many harbors in the United States fail to meet water quality standards mandated under the Federal Clean Water Act. Reasons for this are numerous. One contributing factor, that the standards applied are often inappropriate for harbor conditions, is investigated in this paper. Many harbors are required not only to provide for the diverse needs of navigation but also to meet the water quality requirements for secondary contact recreation (boating), the maintenance and propagation of aquatic life (fishing) and primary contact recreation (swimming). Two very different harbors, the relatively small inland Port of Green Bay, Wisconsin and the extremely busy Boston Harbor, Massachusetts, are cited as case studies.

Water Quality Standards Development

The passage of the Federal Water Pollution Control Act (FWPCA) by the US Congress in 1972 and its subsequent amendments (which changed the name to the Clean Water Act (CWA)) established new water quality goals and programs. The CWA defined the national goals to be elimination of all pollutant discharges and restoration of all waters to "fishable and swimmable" condition. "Fishable" was defined in the CWA to be the protection and propogation of a balanced population of fish, shellfish, and wildlife while "swimmable" was defined to include recreational activities in and on the water.

The CWA and its implementing guidance (United States Environmental Protection Agency (USEPA), 1983) dictate how water quality standards are set for all water bodies. Although state water quality agencies are responsible for actually setting the standards, all states must comply with the overall process dictated by USEPA.

The water quality standards are composed of two parts:

1. The designated uses for the water body in question
2. The water quality criteria required to support those uses.

Commonly, states define the "designated beneficial use" to be applied to each water body. These uses are either currently being achieved (actual uses), or could be expected to be achieved (potential uses) if the water quality were upgraded. Typical beneficial uses frequently designated for water bodies include:

- Drinking water supply
- Primary recreation (swimming, full body contact)
- Secondary recreation (boating, partial body contact)
- Aquatic life protection

Aquatic life protection uses are further subdivided depending on the nature and location of the water body, for example:

- Warm water fishery
- Cold water fishery

- Seasonal cold water fishery
- Shellfish, without depuration (ie., holding in clean water to flush contaminants prior to human consumption)
- Shellfish, with depuration

The water quality criteria required to support each use are normally based on scientific studies of the water quality characteristics necessary to support the use. Criteria normally cover physical characteristics (allowable temperature range, maximum suspended solids concentrations) and chemical characteristics (minimum dissolved oxygen (DO) concentrations, allowable pH range). Many standards also include "narrative" criteria for unquantified characteristics which affect water uses, e.g., no substances may be present which impair aesthetic enjoyment of the resource, or no toxic substance may be present in toxic amounts. Recently, states are being required to translate narrative criteria for toxics into numeric criteria.

The primary purpose of the water quality standards is to protect existing and potential water uses. National (or state) Pollution Discharge Elimination System (NPDES) permits are issued to known "point" sources of contaminants to prevent pollutant discharges which would cause violations of the criteria and hence threaten water uses.

Section 305(b) of the CWA requires the USEPA to report to Congress every other year on the progress achieved in moving towards the goals of the Act. Typically, this assessment is made by determining whether or not the criteria are met. Review of whether or not the uses are being met is rare. In some cases, the existence of fish consumption advisories, evidence of widespread fish disease, closed shellfish areas and periodically or permanently closed beaches are considered.

Use Attainability

By inference, many assume that if known pollution sources are controlled, the water quality criteria will be met and the designated uses will be achieved.

In fact, there are many impediments to achieving designated water uses and water quality criteria beyond those addressed in the NPDES permits. Sources of materials which affect water quality and are beyond the control of the existing point source permit system include:

- Culturally caused non-point sources such as agricultural runoff and illicit discharges of sewage from boats in marinas
- Natural non-point sources, such as the organic runoff from a forested area, acidic organic inputs from wetlands, or animal wastes
- In-place pollutants, such as heavy metals or organic compounds found in the sediments below quiescent waters, but which can be released back into the water column under certain conditions or taken up into the food chain by fish and other aquatic life.

In addition, a number of physical and other factors unrelated to water quality standards may adversely affect the ability of a water body to achieve its designated use:

- Lack of cover (overhanging banks, rooted aquatic vegetation) may render a water body unsuitable for fish subject to predation. This is particularly critical to young fish.
- Depth of water may be too shallow or too deep for some species of aquatic life. Similarly, depth characteristics may make a particular water body unsuitable for swimming (a navigation channel frequently drops off too quick-

ly for safe swimming, not to mention boat hazards). Obviously, water bodies may be too shallow for most forms of boating.

- River flows or harbor currents may be too strong or too sluggish for sensitive life stages of many fish species.
- Desirable uses may be competing and incompatible, e.g., commerical or recreational boating may disturb shoreline habitat and discourage aquatic life or waterfowl.
- The bottom substrate material may also be unsuitable for aquatic life; this is especially relevant in certain areas of harbors where dredging and other modifications have irrevocably modified the bottom characteristics.
- Overfishing may adversely affect the fishery and confound attempts to assess factors responsible for declines in this resource
- Insufficient water clarity, sometimes the result of natural causes, may restrict recreational uses such as swimming
- Chemical constituents beyond those toxic or harmful, e.g., nutrients, relative proportions of chemicals, etc., may limit suitability
- Cultural influences, such as restricted access to the shore for recreation and disturbance of competing uses, may limit aesthetic enjoyment and boating

Water quality criteria, therefore, address only some of the factors necessary to protect the designated uses. The attainment of designated uses cannot be achieved in all cases through the application of the conventional standards-to-permit process.

USEPA, through use attainability analysis, allows full consideration of these issues when establishing designated uses and water quality criteria. The CWA requires states to review (and revise when applicable) their water quality standards at least every three years. During these triennial standards reviews, use attainability analyses can be effectively used to ensure that designated uses do, in fact, reflect actual or potential uses.

Use attainability analyses, however, are not frequently performed. They often require technical and economic resources most state regulatory agencies can ill afford. Furthermore, many state officals and citizens groups associate use attainability with the politically unpalatable concept of relaxing standards. Consequently, the states often mandate uses and water quality criteria which may not be achievable due to factors unrelated to water quality.

Case Studies

The following provides two brief case studies of harbor water quality standards and use attainability considerations. For the first case study, Green Bay, Wisconsin, the water quality standards have been the subject of controversy for a number of years and several public and private agencies have reviewed the use attainability issues. The second case study, Boston Harbor, has only recently become the focus of public attention. Use attainability considerations cited here for Boston Harbor are consequently speculative - further study and understanding of the harbor will be required before its "use attainability" can be fully defined.

Green Bay

Green Bay lies at the mouth of the Fox River on the west central shore of Lake Michigan. The Port of Green Bay includes several commercial docks servicing ocean-going vessels which enter the Lakes through the St. Lawrence Seaway. The

1.7 million short tons of cargo which passed through the harbor in 1987 represents an economic value of $56 million, including sales, income and taxes (Port of Green Bay, 1988). The harbor area is also a very popular recreational boating area.

The Wisconsin Department of Natural Resources (WDNR) has designated the beneficial uses of harbor waters to be primary and secondary recreation, and fish and aquatic life protection and propogation. Until recently, the WDNR had provided a variance for the harbor from the general dissolved oxygen (DO) standard of 5 mg/l. The variance was allowed in recognition of natural or irretrievable man-induced phenomena which prevented consistent attainment of the standard. It allowed DO levels to be as low as 2 mg/l. This variance was removed by the WDNR in 1986.

Limitations on the designated uses of the general harbor area include the inability to provide a self-sustaining fishery for walleye (they are currently stocked by the WDNR) and fish consumption advisories due to fish tissue concentrations of PCB. Recreational impairment includes water transparency limitations which restrict swimming at certain locations and beach closings caused by high bacteria counts. Water quality criteria violations have included low DO, high ammonia, and high bacteria concentrations in specific locations.

Two separate water quality standards reviews were performed in 1985 for the lower Fox River and inner Green Bay in relation to the proposal to remove the DO variance. One of these was performed by CH2M HILL (CH2M HILL, 1985). This study concluded that the factors which are of dominant influence with respect to the fishery potential of the harbor area include:

- Lack of suitable habitat for desirable species of fish is the principle cause of fishery impairment. Habitat is limited primarily because of navigation related dredging and shoreline modifications, especially along the 4-mile shipping channel
- Low DO concentrations are attributable more to natural conditions than the wastewater dischargers in this stretch of the river. Seiches in Lake Michigan bring in oxygen-deficient hypolimnetic waters from the bay to the river, and algal respiration and decay further deplete oxygen resources. Furthermore, the DO violations which do occur do not have an adverse effect on the fishery because warm-water species are tolerant of short-term DO declines below 5 mg/l and these declines do not often occur at times when the most sensitive early life stages of the fish are using the harbor area.

The second standards review was performed by the WDNR (WDNR, 1985). This analysis concluded that increased wastewater treatment since passage of the CWA had dramatically improved water quality conditions in the harbor with a concurrent improvement in aquatic life, including the fishery. They concluded that the 5 mg/l DO standard is generally met (acknowledging the occaisional naturally-caused violations) and is necessary to protect the fishery improvements, including the success of the walleye restoration program. This would also be applicable to the 4-mile shipping channel because the deep water provides cover and serves as a passageway for fish migration. The WDNR recommended that additional wastewater treatment be required to ensure that the 5 mg/l standard is never violated due to causes other than those of natural origin. During the critical periods of low flow and high water temperature, wastewater dischargers are required to reduce oxygen-demanding loads 60 percent below those required with the 2 mg/l standard. The financial impact on the five industrial and three municipal dischargers to the harbor area is substantial. Capital costs for improvements to the largest municipal treatment plant (which had been previously upgraded in 1975) are likely to exceed $120 million. Treatment plant improvements will also include ammonia removal to protect the aquatic life use designation.

Boston

Boston Harbor is one of the busiest and largest harbors on the eastern seaboard. It is also generally considered to be among the most polluted harbors in the U.S., reflecting decades of activities in and around the harbor. Like most harbors, it is the downstream terminus, or sink, for pollutants generated in the upstream watershed.

Designated uses for the harbor include:

- Marine fishery
- Secondary contact recreation
- Shellfishing, with and without depuration (not including the Inner Harbor)
- Primary recreation (not including the Inner Harbor)

These designations recognize lower quality uses for the main shipping area (the Inner Harbor) but the existing water quality criteria do not consistently reflect these conditions. The DO standard for the Inner Harbor is the same as that for other estuarine areas in the harbor. Recreation related bacteria standards are less restrictive for the Inner Harbor. Nevertheless, both DO and bacteria violations are commonplace in the Inner Harbor. Excursions from standards and related use impairment in other harbor areas are also widespread:

- Fishery impairment - fish consumption advisories exist for lobster and flounder; about half of the designated shellfish area is closed due to bacterial contamination; widespread fish disease has been documented
- Recreation - Beaches are frequently closed due to bacterial contamination and there is substantial aesthetic impairment due floating debris, scum and other sewage related material

There are also use impairments unrelated to water quality conditions. These include limited fishery habitat in the Inner Harbor area due to dredging and other navigation related activities, and barriers to anadromous fish migration (dams on the major rivers feeding into the harbor). Recreational use is restricted in many areas of the harbor due to limited public access facilities.

Summary and Conclusions

The preceding case studies illustrate the implementation of costly measures to further reduce pollutant loadings to harbor areas that might be unsuccessful in their intended objective of restoring beneficial uses. In evaluating proposed water quality control measures, the authors recommend full realization that:

1. Water quality standards are intended to protect the designated uses of surface waters.
2. Factors beyond water quality often prevent achieving the designated uses, especially in major harbors where physical modifications have reduced aquatic life habitat (eg., dredged shipping channels).
3. Water quality related use impairment is often not controllable through the normal standards-to-permit process. In-place polluted sediments restrict habitat and introduce contaminants into the food chain, thereby contributing to fish consumption advisories. Nonpoint sources of pol-

lutants, such as agricultural and silvicultural activities and urban stormwater runoff, also contribute harmful pollutants.

4. More applicable standards and criteria can be developed through use of USEPA regulations which provide for use attainability analyses, use of site specific and/or seasonal criteria, variances and sub-categories of use. Examples of improved use designations and criteria for major harbors include:

- Navigation use for dock areas and/or shipping channels
- Differentiation of spawning and migration areas from adult feeding areas
- Definition of seasonal criteria to protect critical spawning and migration uses but not providing year-round protection if it is not necessary for the fishery resource.

References

Ball, Joseph R., ed., 1985, *Lower Fox River, DePere to Green Bay Water Quality Standards Review*, Draft, Wisconsin Department of Natural Resources, Bureau of Water Resources Management and Bureau of Fish Management, Madison, Wisconsin.

CH2M HILL, 1985, *Fishery Potential Analysis for the Lower Fox River and Inner Green Bay*, prepared for the Industry River Study Committee, Milwaukee, Wisconsin.

CH2M HILL, 1988, *Planning Area Water Uses and Water Quality Standards*, Technical Memorandum 2-3, Combined Sewer Overflow Facilities Plan, prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Port of Green Bay, 1988. Annual Economic Impact Report.

U.S. Environmental Protection Agency, 1983, *Water Quality Standards Handbook*, Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, D.C.

NEW ENGLAND PORT GEOGRAPHY: AN UPDATE

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1. Introduction

The genesis of this research emanates from an earlier study which has demonstrated the validity of shift-share analysis toward aiding the port geographer/planner in decision making (Marti, 1982). A major conclusion of the previous work was that "each port's situation must be studied in coordination with the relative situation at competing ports."

This present study logically draws upon and extends that preceding effort. It focuses once again on the same region and its ports—New England. The initial study year for both papers is 1968, but the terminal year in this paper is advanced seven years and includes data for the most recent year available, 1985. Data reviewed and analyzed here were obtained from the records of the U.S. Army Corps of Engineers (U.S. Department of the Army, 1968 and 1985). The data consist of all foreign and domestic waterborne commerce handled at respective ports by four-digit commodity codes.

The paper's purpose is threefold:

1. to provide a generalized narrative of the various aspects of port competition;
2. to review, through use of descriptive techniques, the status of the New England port system; and
3. to measure interport competition among New England's ports by means of a shift-share analysis.

2. Port competition

The principal function of most ports is to facilitate the transfer of cargo from ship to shore and vice versa. Ports, by their very nature, must compete with one another for cargo and associated revenues. However, technological change experienced during the latter half of the twentieth century has greatly increased the levels of capital required by ports to enable them to provide an efficient and effective service.

The two divisions of port-related capital investment are:

1. port infrastructure—construction that allows vessels to berth at the land/water interface; and
2. port superstructure—facilities or equipment to move cargo between the ship and the land.

Revenue earned by the port from marine operations include dockage fees for using port infrastructure, and wharfage charges for using port superstructure. The problem presented by intensified port competition is that port revenues are directly related to port throughput, and there is only a finite amount of cargo that moves through regional commerce over a discrete time period. Thus, competition creates ports that are winners and others that are losers in a "zero sum game." If a port's marine revenues are not sufficient to cover expansion or developmental costs, then either non-maritime economic activity revenues or other sources of funding must be sought to begin and complete necessary projects. Typically, public ports without the ability to generate enough revenues from port-related activities request subsidies or other means such as general obligation or revenue bonding to finance improvement.

Ports have traditionally marketed both shippers and carriers to induce increased levels of business. This previous practice was driven by a "which comes first" attitude, similar to "the chicken and the egg" argument that ports neither can attract vessels without cargo nor attract cargo without vessels. However, advances in information gathering, especially regarding competitor volume data and carrier loadings statistics, have promoted change with a greater emphasis on the marketing of port services to carriers.

3. General description of New England ports

Despite the adverse impacts of several location and economic factors which have impeded growth and created decline, New England's ports have survived, although they are not anywhere as vital as they have been in the past. Reasons for decline include:

1. the geographic location of the region's ports sandwiched between the more active facilities of the Port of New York-New Jersey to the south and Canadian Maritimes' facilities at Halifax and St. John to the north;
2. the diversion of cargo from natural hinterlands or tributary areas by non-regional competitors;
3. the attraction of Midwestern cargoes, which formally flowed through New England, by such ports as Philadelphia, Baltimore, and Montreal;
4. the relative decline of U.S.-European international trade in comparison to the spectacular growth in U.S.-Far Eastern trade; and
5. the adoption and the heavy use of intermodalism and landbridge, which favors large ports at the expense of small and intermediate-sized facilities.

Additionally, the close proximity of New England ports to each other further heightens interport competition for limited amounts of cargo.

Figure 1 is a graphical presentation of New England's port status in 1968 and 1985. The broad categories in the visual might provide an impression of stability or slight decline, but a closer inspection of the data reveals an absolute region-wide loss of nearly 30 million tons, from 77,568,994 to 47,702,754. Almost 60 percent of that loss is attributable to a decrease in Portland's imports. It should also be noted that receipts/shipment (domestic movements) comprise a significant proportion of most port's total traffic; and in all but one case, that of Searsport, domestic cargo throughput was much lower in 1985.

Table 1 reveals the import-export ratios for the eight ports in the study region. In both years, most port ratios were integers exceeding one, indicating (based on measures of tonnage) a bias of inbound foreign cargoes. Furthermore, this ratio grew smaller over time for four ports, and was affected by either a large decline in imports or, in some cases, a moderate increase in exports. Growth of the index in 1985 for several ports was caused by a larger relative decline in imports *visa vis* exports.

To illustrate the importance of the nature of cargo and its unique relationship with specific port superstructure requirements at individual facilities, export and import commodities were aggregated into three major cargo categories— dry bulk, liquid bulk, and general cargo. Although specific commodities can be classified easily into the first two groups, assignment to the two subgroups of general cargo—break-bulk and unitized—is at best speculative. Realizing that handling characteristics and port superstructure requirements vary for general cargo, the only alternative that was deemed reasonable was to include all non-traditional bulk items, including neo- bulk, into the general cargo classification. A comparison of each port's cargo type for both study years can be seen in Figure 2. Cargo types, expressed on a percentage share basis at individual ports, show that liquid bulk commodities dominated imports at most New England ports. The only exceptions noted were the influences of general cargo at Bridgeport and New London in the terminal study year. A mixed degree of importance of liquid bulk can also be interpreted, with liquid bulk increasing in importance at some ports, while decreasing at others. The export segment percentage share analysis indicates that either dry bulk or general cargo were the major cargoes exported from individual ports. Two striking trends are evident—the minimal contribution of liquid bulk, and the generally increasing reliance on dry bulk for exports.

A final manner of descriptively analyzing port throughput statistics in a comparative way relies on the index of specialization. This index is derived by computing the percentage share of each commodity at each port, then summing the squares of each percentage, finding the square root of the sum, and multiplying by 100. As the index of specialization for a port approaches 100, it indicates concentration or heavy dependence on a few commodities. The further away the index is from 100, the more diversified a port is, since it is handling many different commodities. Table 2 records the index of specialization for New England's international trade. On the import side, most facilities were highly specialized, although the general trend is toward diversification over time. For exports, some facilities experienced concentration while others experienced diversification. Yet the overall trend was much more stable than for imports.

4. Shift-share analysis of New England Ports

Since shift-share analysis cannot explain why a certain phenomenon has grown or declined or why locational shifts have taken place, it is a purely descriptive technique. Nevertheless, this technique offers valuable insight toward explanation of regional change.

The technique, when applied to port traffic data, apportions change (either loss or gain) into three respective components. The first component, the regional share, assumes that the relative amount of total commerce handled at respective ports remains constant throughout time. Thus, if an individual facility handled 20 percent of the region's cargo in the initial study year, it then handled 20 percent of the region's cargo in the terminal year. The second component, the proportionality shift, displays traffic fluctuations based on varying rates of growth for specific commodities. If the total trade package of a port is increasing at a faster rate than the regional average, positive tonnage figures result; however, if the opposite is prevalent, negative tonnage figures result. In effect, the proportionality shift reflects the impact of fast- and slow- growing regional cargoes. The last component, the differential shift, measures cargo captured from other regional facilities. The sum of the differential shifts for all ports equals zero; thus, each port's gain is balanced out by other ports' losses.

Table 3 reveals the raw data and the results of the shift-share analysis for imports at New England's ports. All ports experienced negative regional shares, since the region's total cargo was declining. However, a different picture was found by examining the proportionality shift. With the exception of Portland, all ports were found to have positive shifts, indicating that they were handling predominantly fast-growing or glamorous cargoes. The differential shift shows cargo capture at all ports except Bridgeport, New London, and Searsport.

Table 4 contains the data and results of the shift-share analysis for New England's exports. Since regional exports grew, all ports earned positive regional shares; however, the magnitude of gain was not as large as the losses attributed to imports. The proportionality shift component varied from port to port, with three ports, Bridgeport, New Haven, and Providence, handling relatively fast-growing cargoes and the remaining ports either handling no exports, or specializing in slow-growing cargoes. Negative differential shifts, or cargo losses to other ports, were exhibited by Bridgeport and Searsport.

5. Conclusions

This paper has introduced several important aspects increasing competition among ports and some of its implications on port development and expansion. An overview of New England port competition, utilizing descriptive analyses, has highlighted that although New England's ports are declining in relative importance, exports are growing moderately. The shift-share analysis for imports and exports provides further insights, since it divides gain or loss into specific components. Decline in import cargoes has resulted mainly due to reductions in petroleum imports, the region's major cargo. This decline has been so severe that most other commodities are growing at a faster rate than the average of all cargoes combined. Cargo capture at some ports is at the expense of losses at others. Although advances in export tonnages are moderate, the identified trend is toward growth. A similar situation appears as that for imports, with some facilities handling fast-growing cargoes while others do not, and cargo capture occurs at all but two ports.

Table 1. New England ports' import-export ratios.

Port	Year	Year
Boston	1968	1985
Bridgeport	11.55	9.05
Fall River	*	*
New Haven	13.50	8.99
New London	*	710.71
Portland	18,490.08	213.30
Providence	9.01	5.65
Searsport	19.80	27.58

Note: an asterisk indicates that the particular port did not report exports in the respective year.

Table 2. New England's international trade indices of specialization, 1968 and 1985.

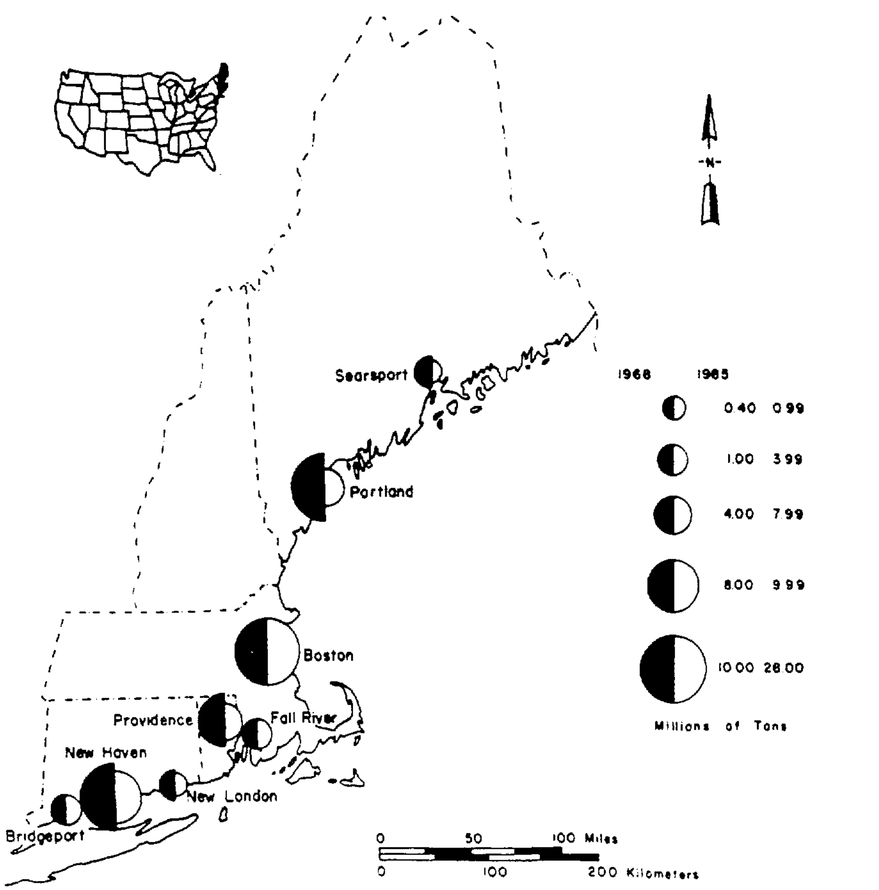
Port	Imports		Exports	
	1968	1985	1968	1985
Boston	77.71	47.61	82.37	89.43
Bridgeport	69.70	69.98	100.00	60.39
Fall River	62.37	60.68	0.00	0.00
New Haven	79.82	43.81	99.35	97.71
New London	83.45	53.41	0.00	100.00
Portland	94.87	73.82	71.80	71.14
Providence	89.44	46.04	98.56	100.00
Searsport	69.82	80.66	63.64	96.47

Table 3. New England's maritime imports, 1968-1985.

Port	Total 1968	Total 1985	Regional Share	Proportionality Shift	Differential Shift	Total Shift
Boston	8495110	6851540	-4803296	2665553	494173	3159726
Bridgeport	1136943	573461	-642849	499384	-420017	79367
Fall River	349240	354098	-197467	170158	32167	202325
New Haven	2796162	2260913	-1581003	1011464	34290	1045754
New London	662587	224585	-374639	175077	-238440	-63363
Portland	22668841	4702739	-12817390	-5475159	326447	-5148712
Providence	1770236	1358311	-1000925	506122	82878	589000
Searsport	825721	494746	-466878	447401	-311498	135903
Total	38704840	16820393	-21884447	0	0	0

Table 4. New England's maritime exports, 1968-1985.

Port	Total 1968	Total 1985	Regional Share	Proportionality Shift	Differential Shift	Total Shift
Boston	735388	757165	27145	-14042	8674	-5368
Bridgeport	62521	705	2308	4884	-69880	-64124
Fall River	0	0	0	0	0	0
New Haven	207075	251497	7644	15322	21456	36778
New London	0	316	0	0	316	316
Portland	1226	22048	45	-1075	21852	20777
Providence	196588	240765	7256	13085	23836	36921
Searsport	41697	17936	1539	-18174	-7216	-25300
Total	1244495	1290432	45937	0	0	0



	1968				1985			
	IMPORTS	EXPORTS	RECEIPTS/ SHIPMENTS	TOTAL	IMPORTS	EXPORTS	RECEIPTS/ SHIPMENTS	TOTAL
BOSTON	8,495,110	735,388	12,372,338	21,602,836	6,851,540	757,165	9,212,227	16,820,932
BRIDGEPORT	1,136,943	62,521	2,175,153	3,374,617	573,461	705	1,830,059	2,404,225
FALL RIVER	349,240	0	2,839,812	3,189,052	354,098	0	3,608,935	3,963,033
NEW HAVEN	2,796,162	207,075	7,983,386	10,986,623	2,260,913	251,497	6,800,757	9,313,167
NEW LONDON	662,587	0	749,351	1,411,938	224,585	316	274,282	499,183
PORTLAND	22,668,841	1,226	4,333,351	27,003,418	4,702,739	22,048	2,818,435	7,543,222
PROVIDENCE	1,770,236	196,588	6,879,656	8,846,480	1,358,311	240,765	4,719,141	6,318,217
SEARSPORT	825,721	41,697	286,612	1,154,030	494,746	17,936	328,093	840,775

Figure 1. New England's port status, 1968 and 1985.

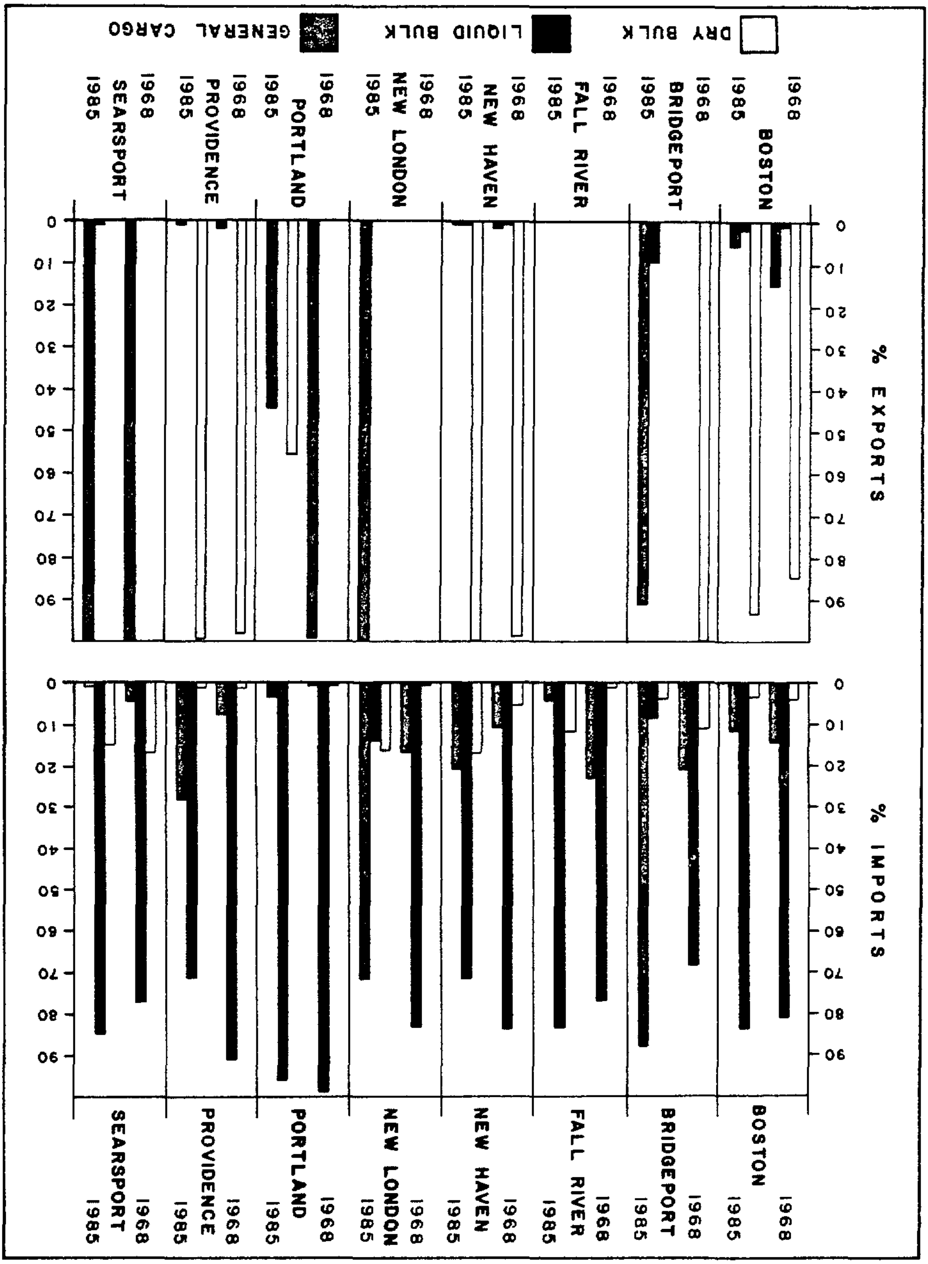


Figure 2. New England ports, by cargo type, 1968 and 1985.

References cited:

Marti, B.E. (1982) "Shift-Share analysis and port geography: New England example," *Maritime Policy and Management*, 9:4, 241-250.

U.S. Department of the Army, Corps of Engineers (1968 and 1985) *Waterborn Commerce of the United States.*

Consensus Planning for Massachusetts Harbors

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Communities in Massachusetts have long requested state assistance for handling problems in ports and harbors. Local officials claim that the demand for harbor waters and waterfront property has exceeded local management and planning capacity. Multiple juisdictions in harbor areas make harbor planning particularly complex. The Massachusetts Coastal Zone Management (MCZM) Office provides technical and financial assistance to any coastal municipality examining the future needs and opportunities of their harbors. The Harbor Planning Program encourages communities to comprehensively plan harbor areas using a consensus building model for local involvement.

MCZM staff developed the Harbor Planning Program over a period of two years. With extensive assistance from local planners, harbor users, other coastal states, and the interested public, staff constructed a program designed to meet the needs of Massachusetts' harbor users while meeting state and federal standards for waterfront development and harbor management.

The Special Nature of Harbors and Planning

Harbors are a unique natural and man-made resource. They are usually located in the center of an urban area. Dense, urban development places pressure on natural resources that may become depleted or destroyed. Also, the great variety of users found in harbor areas compete for these limited resources. Commercial, recreational, industrial and housing developments can all be found in many Massachusetts harbors. Finally, many authorities have jurisdiction in harbor areas and may have competing or even conflicting regulations and policies. All of these factors combine to produce a challenging planning situation.

Given the complexity and difficult nature of managing harbors, how can *comprehensive* planning help? Comprehensive planning is the process of creating a direction for land and water uses of the harbor simultaneously. The process of planning should identify possible futures of the harbor area as well as solutions to specific problems. Planning which uses a consensus building model provides the local officials and harbor users the opportunity to better understand each other's interests. People can potentially close gaps of disagreement that may have been in place for years. A well-developed plan will lead to action and settlement of many issues. The plan should discuss how to bring the appropriate resources to bear to accomplish specific goals. Lastly, a successful plan will provide a structure for following through on decisions made.

Key Components to Comprehensive Harbor Planning

Comprehensive planning in harbors requires that communities examine the issues on the waterfront as well as those in the waters of the harbor. The harbormaster must be willing to discuss his/her plans for the future of the harbor with the planning board which will be deciding the types of development which will be allowed on the waterfront. Instead of piecemeal decisions being made as proposals come forward, all those directly involved with the harbor area design, in advance, the future harbor they want to see. Instead of these individuals making separate plans, they work together coordinated by someone trained in planning and group process.

MCZM recommends the use of an "open planning" or consensus planning process. In open planning, the people directly involved with the harbor participate in plannning throughout the process. Representatives of all interest groups meet together to design the plan and make decisions at many junctures. This "core group" decides the goals of the harbor, the technical information needed and the problems to be analyzed. They review analyses of the existing situation and help develop alternative solutions to problems that meet all of their specific needs. They work with the community in gaining broad input into any decisions made. The core group directs the planning effort rather than following behind it as advisory committees often do.

MCZM advocates the use of the consensus building model in planning because, in the past, many comprehensive plans have either been shelved or challenged. A "shelved" plan is one that is not perceived as valuable and does not enjoy the support of the community. In order to generate the support necessary to implement the plan, all affected interest groups should participate in development of the plan. In order to avoid legal or procedural challenges to a plan, all the concerns of the waterfront users should be incorporated into the plan through their direct representation in the planning process. Experience has shown this model can produce acceptable, practical plans that may be implemented over time.

Another key component to successful harbor planning is getting the right technical information incorporated into the plan. The right information is the information needed to answer the pressing questions of the next 5-20 years. Questions that surface in Massachusetts include: How many moorings and marinas can this harbor hold? What is the current water quality? If the waterfront was developed to the current zoning ordinances, what would the waterfront look like? What might the expansion or contraction of port activities do to the recreational uses of the harbor? With answers to the relevant harbor development questions, the core planning group can set goals and objectives and examine different scenarios for the future.

Finally, a plan that cannot be implemented over time has little value. The objective of planning should be to effect changes in the harbor area. The planning process should be designed to lead to action and set policy that local, state and federal decision- makers can use in their decisions.

Comprehensive Planning in Massachusetts

State land use planning in Massachusetts is an anomaly. Rarely do state officials have the opportunity to influence local planning decisions in a state where "home rule" is the dominant theme. Recognizing this fact, MCZM carefully pursued their goals to balance harbor preservation and development. First, the staff developed *Harbor Planning Guidelines* (1988), and a manual on public involvement (See the *Guide to Public Involvement*, 1987). Simultaneously, MCZM offered technical assistance to communities on any harbor planning issue. Later, the office obtained $1 million in grant funds to distribute to communities completing comprehensive harbor plans.

The *Guidelines* offer the state perspective on the type of planning needed to balance growth and development with the long- term protection of the unique natural resources of the coast. MCZM recommends that communities closely examine future waterfront development restrictions that may be needed to protect water-dependent uses and waterfront character. Water quality analysis and planning must be completed in order to address the severe degradation of water in Massachusetts harbors. Dredging master planning, mooring management and natural resource management must also be part of the comprehensive plan.

The *Guidelines* were written with the assistance of communities already involved in harbor planning. MCZM held regional workshops where those that would be using the document offered recommendations and highlighted new issues. By giving people the opportunity to influence what would eventually be the standard for planning in the state, the staff hoped to increase local interest in and ownership of the planning process. In effect, we were practicing what we preached.

Whether communities were interested in following our guidelines or not, we offered the assistance of our staff of biologists, geologists, planners, lawyers, and policy analysts. MCZM staff visited communities at local meetings and offered technical advice on issues such as waterfront zoning, mooring management, and water quality assessment. By being available locally, we built trust and a reputation for being knowledgeable in harbor planning.

Simultaneously, the staff lobbied the legislature for authorization of a $1 million bond to fund communities in completing what would be for many an expensive, time-consuming planning process. MCZM obtained the funding and offered it to communities in the form of a 50/50 matching grant which allowed a maximum of $50,000 to be awarded to any one community. This money was key to ensuring that communities would effectively manage their harbors consistent with MCZM coastal policies.

Currently, the office hopes to distribute the first third of the bond money in calendar year 1989. Several communities are waiting in the wings ready to move into the next stages of planning. Many communities have begun comprehensive harbor planning, some using only a portion of the *Guideines* and others pursuing the process outlined. In virually all cases, the office is pleased with the progress of cities and towns and their efforts to adapt the Guidelines to local needs. MCZM expects the future demand for Harbor Planning to continue to rise. Within one year to 18 months, we hope to be able to point to completed comprehensive plans. And, more important, we hope to see the effects of better management of our precious gems, our harbors.

POTENTIAL APPLICATIONS OF SEDIMENT QUALITY MEASURES TO MANAGEMENT DECISIONS

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Abstract

In response to growing concern regarding the effects of contaminated sediments on the aquatic environment, a number of methodologies are being devised to address the impacts on aquatic life of in-place toxic chemicals. The various measures of sediment quality resulting from these approaches, which may serve as useful tools in identifying contaminated sediments, fall into two categories: 1) those reflecting the impacts of individual chemicals, such as the criteria developed through the water quality criteria-based "equilibrium partitioning" (EP) approach, and 2) those addressing the effects of chemical mixtures, derived through bioassays, benthic community assessments, and approaches utilizing a combination of the above (e.g., the "sediment quality triad" or "apparent effects threshold" approaches).

To date, guidance on the application of sediment quality measures to regulatory and management decisions is lacking. This paper summarizes current sediment quality measures and their potential applications to decisions regarding the assessment and remediation of contaminated sediment. For accurate, cost- effective assessments of sediment quality we recommend a tiered approach involving, in the following order: chemical-by-chemical criteria derived through the EP approach; a sediment bioassay screening step; use of site-specific information for evidence of contamination by a known chemical(s) for which EP-based criteria are not yet available; and a sediment quality measure(s) reflecting the biological effects of chemical mixtures.

Introduction

For some time, the Environmental Protection Agency (EPA) and other Federal agencies have used a number of biological and chemical assessment techniques to address toxic pollution in our nation's waters. In recent years we have come to realize that chemical contamination of sediments, too, can have profound effects on aquatic ecosystems. Toxic sediments can adversely affect and contaminate benthic organisms which are critical to marine and freshwater food chains, and can act as a source of contamination to the water column, making it unsuitable for recreational activities such as swimming and fishing.

A variety of methods are being developed to address the impacts on aquatic life of in-place toxics. Measures of sediment quality resulting from these approaches may serve as useful tools in assessing and managing potentially contaminated sediments. The measures may either 1) reflect the impacts of individual chemicals, or 2) address the effects of chemical mixtures. All sediment quality measures in the first group, and some in the second, consist of sediment concentrations for specific chemical contaminants such that sediments with contaminant concentrations exceeding threshold values are considered deleterious to aquatic life. Measures in the second group (i.e. addressing chemical mixture effects) may also take the form of "number of toxicity hits" (for bioassays), or a parameter(s) representing infauna community structure.

Many sediment quality assessment methods are "new" on the scene, and national guidance is not yet available on how they might be used in a regulatory context. This article summarizes current methods for assessing sediment quality and potential applications of these methods to management decisions. In the coming year, EPA will be developing a detailed technical manual on some of these methods, to help potential users identify methods most useful for their specific purposes. The type(s) of data employed by the different methods are shown in Table 1.

Chemistry Approach

In the chemistry approach, bulk sediment concentrations of chemicals of concern at a potentially contaminated site are compared to concentrations at a reference site or to concentrations which relate to some incremental change above background levels and that are assumed to have adverse effects on biota. The approach is simple and employs chemistry data only, but since few cause-effect relationships have been established between bulk sediment concentrations and biotic impacts, its use as a sole criterion to determine sediment quality is questionable.

This approach forms the basis of guidelines established by Canada's Ontario Ministry of the Environment (MOE) for evaluating the acceptability of dredged material for open-water disposal. It has been used for the same purpose, in conjunction with other methods, by Region V of the EPA (1977), the U.S.-Canada International Joint Commission (IJC, 1982), and the U.S. Army Corps of Engineers (Francingues et al., 1985).

Sediment Bioassays

In the sediment bioassay approach, test organisms are exposed to field-collected sediments with or without measured contaminant concentrations. Mortality or sublethal effects in different sediments (sites) are compared quantitatively to one another or to effects observed in reference sediments. Bioassay data are generally in the form of percent toxicity "hits", or significant toxic responses. The sediment bioassay approach captures the effects of all toxicants acting as a mixture, accounting for whatever additive or synergistic effects may be occurring. [Sediment extract tests may not account for *all* toxicants—see below]. For this reason, the approach is particularly useful for identifying problem sediments. On the other hand, it requires integration with another approach to yield chemical-specific values of sediment quality (should they be desired).

Through the use of spiked bioassays—exposing test organisms to sediments with known amounts of chemicals and establishing dose- response relationships—chemical-specific values of sediment quality can be derived. The spiked bioassay approach requires a large research effort to establish an extensive benthic toxicological data base, and will not be discussed further. Sediment bioassays fall into three categories, depending on the specific exposure route: whole intact sediment, or "solid phase" bioassay; sediment elutriates (suspended phase or liquid phase); or sediment extracts (Chapman, 1987). Sediment elutriate tests are designed to assess the effects of chemical contaminants released from sediments to the water column during dredging and disposal. Sediment extract tests depend upon an extraction procedure that is specific for neutral, nonionic organic compounds and therefore may not accurately reflect real-world contaminant availability. The solid phase bioassay utilizes intact "solid" sediments to examine the effects of *both* bound and dissolved contaminants on benthic organisms.

The sensitivity of bioassays is controlled by the sensitivity of the biological species employed, and the level of response measured (i.e. test endpoint). Chemical concentrations that might elicit sublethal responses such as abnormality in larval development or change in respiration rate might not elicit an acute lethal response such as mortality. Most workers agree that a suite of sediment bioassays should be used in wide-scale surveys of sediment contamination (Long, 1985; Williams et al., 1986). The 10-day acute amphipod *Rhepoxynius abronius* test (Swartz et al., 1985a), which measures mortality in individuals exposed to whole sediment, is the most commonly employed bioassay for evaluating contamination in marine sediments. Other representative marine and freshwater sediment bioassays are listed in Chapman (1987) and Lamberson and Swartz (1988), respectively.

Sediment bioassay data were used by Long (1983) to rank subareas in Puget Sound in terms of toxicity to benthic organisms. Such information can then be used to priority rank remedial actions. Subareas could de definable physiographic features, as in Long's study, or places for which individual management options are being considered (e.g., receiving zone for a point source discharge). A number of workers have used sediment bioassays to investigate the spatial distribution of sediment toxicity in relation to pollution gradients, for example Swartz et al., 1985b, off a sewage outfall. In that study, overall bioassay results correlated with the spatial distribution of macrobenthos and sediment contamination. Sediment bioassays are used in conjunction with infaunal community analysis and chemistry data in the Sediment Quality Triad approach (see below; also see AET approach). A number of bioassays are being considered for use as measures of biological effects to accompany chemical analyses in NOAA's National Status and Trends Program (E. Long, NOAA, pers. comm.). Elutriate and solid phase sediment bioassays have been used by the Army Corps of Engineers to evaluate the sediment quality of dredged material (EPA/COE, 1977). An ongoing study by EPA's Regional Office in Seattle, Washington, is comparing the sensitivities of different marine sediment bioassays, and includes examination of some chronic tests (PTI, 1988a). Chronic tests are employed over a time period of at least one generation; very few accepted ones currently exist for marine systems.

Infauna Community Structure

The community structure approach looks at the numerical abundance of species in a community. There are two principal types of community structure indices: diversity indices and similarity indices. Diversity indices depend on the number of species (S) and the abundance of individuals within species (N). The Shannon-Wiener index H' has been used extensively among ecologists but its biological relevance has been called into question (Washington, 1984). Any diversity index summarizes community structure in one parameter and thus involves a drastic reduction in the information contained in the overall patterns of the community. Numerical classification, which employs similarity measures (indices) between sites or species, allows simplification of patterns of multi-species distribution which involve far less loss of information (Boesch, 1977). Most similarity measures compare either joint species presence, or presence and proportional abundance. These measures may be particularly applicable in identifying pollutant-induced discontinuities among communities located at varying distances from a source of contamination (Sheehan, 1984).

In order to group "like" assemblages, the similarity matrix is subjected to one of several clustering techniques; these generate cluster diagrams, or dendrograms. Boesch (1977) applied classification analysis on sites and macrobenthic species in the Hampton Roads area, Virginia, to separate heavily polluted Elizabeth River sites from other muddy-sand sites, and to determine the shifts in species occurrence and abundance causing these differences.

Measures of community structure are used in conjunction with sediment bioassays and chemistry data in the Sediment Quality Triad approach (see below; also see AET approach). Examples include species richness, numerical dominance, abundances of major taxonomic groups, and relative major taxon proportions. Due to cost considerations, broad categories such as abundances of major taxonomic groups (e.g., "total crustaceans" or "total polychaetes") are sometimes used in place of measures involving more precise levels of identification. Peer reviews of these approaches have not yet been conducted. Based on conversations with a number of benthic ecologists familiar with these methods, we feel there is a consensus that this is an unsound simplification in most cases. Species and genera within major taxa often have entirely different sensitivities to toxicants, so that abundance of an insensitive species can mask the decreased abundance or even full mortality of a sensitive species in the same major taxon.

Community structure parameters are very useful in assessing sediment quality because 1) they capture the effects of all toxicants acting as a mixture, therefore accounting for whatever additive or synergistic effects may be occurring, and 2) since they reflect *in situ* measurements, they provide a true measure of effects as they occur in nature. On the other hand, comparison of community data to a reference site may be biased by parameters other than contaminants, and the approach requires integration with another approach to yield chemical-specific values of sediment quality.

Screening Level Concentration (SLC) Approach

The Screening Level Concentration (SLC) approach relates the presence of a particular benthic species in field samples to sediment concentrations of a specific contaminant to arrive at a "Species Screening Level Concentration (SSLC)," or the concentration that was not exceeded in 90 percent of the samples containing the species. SSLC values calculated for a number of species are arranged sequentially with respect to increasing contaminant concentration to determine a "Screening Level Concentration (SLC)." The SLC is defined as the SSLC concentration above which 95 percent of the SSLC values are found, that is, the sediment contaminant concentration in which 95 percent of the species have been shown to be able to live. (Neff et al., 1986). For nonpolar organic contaminants, the contaminant concentrations used to calculate SSLC should be normalized to the total organic carbon concentration of the sediment.

Sediment quality values derived through the SLC approach are conservative, and have a high potential for extrapolation to other sediments (areas). The approach may be costly for two reasons: 1) it requires a considerable amount of field data spanning a wide range of contaminant concentrations, and 2) it requires a precise level of infaunal taxonomic identification. The field data associated cost may be somewhat lessened by carefully choosing sites over a known chemical concentration gradient.

The SLC approach was developed, and has been used, as a means of field-validating the Equilibrium Partitioning approach (discussed below); however the SLC's author—J. Neff, Battelle Ocean Sciences—feels that it can also be used as a stand-alone method for assessing sediment quality (pers. comm.).

Water Quality Criteria Approach

In the Water Quality Criteria approach, contaminant concentrations in interstitial water are measured directly and compared with EPA water quality criteria. This approach relies on existing toxicological data (EPA water quality criteria), thus taking advantage of many years of expensive data collection on toxicity of individual chemicals. However, practical difficulties exist with the collection and analysis of interstitial water samples. Standardized and validated procedures for interstitial water analysis have not been established.

Equilibrium Partitioning Approach

The equilibrium partitioning (EP) approach has been recognized by the EPA to have much promise in the development of chemical- specific sediment quality values. Present and past EPA activities have focused on verifying the methodology for Science Advisory Board (SAB) review, scheduled for early 1989. (See Zarba, 1987, for a list of these activities.) Interim sediment "criteria" have recently been developed for the "Superfund" program using this approach (EPA, 1988). These are discussed below.

The (EP) approach is based on water quality criteria, but unlike the "water quality criteria" approach, it incorporates estimating rather than measuring interstitial water concentrations. An underlying assumption of this approach is that the toxicity and accumulation of a contaminant by benthic organisms is correlated to the interstitial, or pore water, concentration and not directly to the total sediment concentration of the contaminant. The approach is based on a simple model that describes the equilibrium partitioning of a contaminant between sedimentary phases which bind the contaminant and interstitial water. In the case of nonpolar organic compounds, sedimentary organic carbon is the primary sorbent, controlling their concentrations in interstitial water and, in turn, their availability to benthic organisms. A sediment quality value for a given nonpolar organic contaminant is the sediment concentration, normalized to organic carbon content, that would correspond to an interstitial water concentration equivalent to the EPA water quality criterion for the contaminant.

For nonpolar contaminants, the organic-carbon-normalized partition coefficient for contaminant x is K^x_{oc}. If a K^x_{oc} value and a water quality criterion, $C^x_{w/cr}$, for contaminant x are known, an organic-carbon-normalized sediment quality value

$C^x_{s/cr}$ can be determined as:

$$C^x_{s/cr} = K^x_{oc} \times C^x_{w/cr}$$

(Tetra Tech, 1986). (K_{oc} values are often estimated from more widely available octanol-water partition coefficients.) The EP approach cannot be used for ionizable organic pollutants because the necessary predictive relationships cannot be reliably determined. The same is true for trace metals at present. However, equilibrium relationships for metal contaminants are currently under investigation. Once these are identified and quantified, the EP approach should be valid for metals.

The EP method uses the same toxicological database as the water quality criteria approach (i.e., EPA water quality criteria) thereby taking advantage of the extensive work done in developing that database, while avoiding the difficulties associated with the direct measurement of contaminant concentrations in interstitial water. Another positive aspect of this approach is that it does not require the collection of biological data. On the other hand, as this approach is based on "chemical-by- chemical" water quality criteria, it does not address the effects of *mixtures* of chemicals. Also, water quality criteria are available for only 17 nonpolar organic chemicals.

Using the EP approach, the EPA recently developed interim sediment quality values or "criteria" for 11 nonpolar organic contaminants (EPA, 1988). For each contaminant, criteria are reported as a mean value and its 95% confidence interval. The confidence interval reflects the degree of uncertainty in the criteria (resulting from uncertainty in the partition coefficients used to calculate them). As an example, the (freshwater) sediment quality criteria for PCB (Aroclor 1254, in ug/gC) is reported as

Mean: 19.5, 95% Confidence Interval: 3.87 99.9

The upper value of the confidence interval represents the concentration which with 97.5% certainty will result in hazardous long-term impacts on the benthic fauna. Concentrations below the lower value of the confidence interval will, with 97.5% certainty, *not* result in chronic effects to the benthic fauna. Concentrations within the confidence interval can be considered either safe or hazardous, depending on the level of certainty chosen.

Interim sediment quality criteria have been applied on a trial basis to a number of Superfund sites around the country. At Sullivan's Ledge, New Bedford, MA, interim criteria for PCB have been applied to sediments of a stream and wetland areas to identify contaminated locations and the areal distribution of contamination for possible remedial action (C. Zarba, EPA, pers. comm.).

The Sediment Quality Triad

The triad approach examines the correspondence among three measures of sediment contamination: concentrations of chemical contaminants in sediment, sediment bioassay endpoints like toxicity, and in situ studies (usually infauna data) (Long and Chapman, 1985). Collecting chemical data in conjunction with biological data allows assessment of sediment quality in terms of the extent of biological damage due to chemical contamination.

The first quantitative approach to the sediment quality triad was attempted by

Chapman (1986) in Puget Sound, Washington. He examined three chemical groups [combustion polyaromatic hydrocarbons (CPAHs), total polychlorinated biphenyls (PCBs), and lead], fish histopathology (selected liver lesions in English sole), and three types of sediment bioassays (*Rhepoxynius abronius* acute lethality, oligochaete respiration effects, and fish cell anaphase aberration). Quantitative sediment quality values for each chemical group were derived by comparing frequencies of biological effects with sediment concentrations of respective contaminants. The sediment quality values were expressed as ranges in three different categories: no or minimal biological effects, major biological effects, and an area of uncertainty. A possible drawback of this study is that the initial grouping of effects frequencies was based on somewhat arbitrary definitions of the "cleanness" of areas from which the effects data were taken.

A second application (Chapman et al., 1987) examined a wide range of chemical contaminants, four types of bioassays, and four infaunal community descriptive parameters (species richness, total abundance, numerical dominance, and relative major taxon proportions). Ratio-to-Reference (RTR) values were calculated for each parameter of each triad component at every station. RTR values provide a measure of the degree of alteration at each station and site compared to a reference site, and to each other. Mean RTR values for each triad component were plotted on scales with a common origin and placed 1200 from each other to form triaxial plots. The area of the triangles for each station at a particular site provided an estimate of the relative degradation of the stations. Similar calculations performed on the means of the sites provided an estimate of the relative degradation of the sites.

Apparent Effects Threshold (AET) Approach

The Apparent Effects Threshold (AET) approach for establishing numerical sediment quality values has its theoretical basis in the sediment quality triad (chemical, bioassay, and infauna) of measurements advocated by Long and Chapman (1985). The AET is one possible way to derive a single index from the triad components.

The objective of the AET approach is to determine concentrations of particular contaminants above which statistically significant biological effects would always be expected (Tetra Tech, 1986). AETs have been calculated (from Puget Sound data) for the following biological effect indicators: 1) depressions in abundances of major taxonomic groups of benthic infauna (Crustacea, Mollusca, Polychaeta, and total abundance), 2) amphipod, *Rhepoxynius abronius*, mortality (through bioassays), 3) oyster larvae, *Crassostrea gigas*, abnormality (through bioassays), and 4) Microtox, *Photobacterium phosphoreum*, bioluminescence (through bioassays). In each case, results at sites with known chemical concentrations are compared to reference conditions to determine whether the biological effect is statistically significant. The AET for a specific indicator is established by the highest concentration at a station without a statistically significant biological effect. The AET method does not prove cause-effect relationships between contaminants and effects, but identifies concentrations of contaminants that are associated exclusively with "polluted" sediments (those having statistically significant biological effects relative to reference sediments).

The AET approach was originally developed to identify problem sediments in Commencement Bay, Washington (Tetra Tech, 1985). The AET database has been subsequently expanded to include other areas of Puget Sound (Tetra Tech, 1986;

1987), and resulting threshold values were used to identify potential problem areas in Elliott Bay where only chemical data were available (PTI and Tetra Tech, 1988).

AET values form the basis of dredged material disposal guidelines recently proposed for the Puget Sound Dredged Disposal Analysis (PSDDA) program (PTI, 1988b). The guidelines incorporate a chemical screening level, SL, and a maximum level, ML, for each chemical of concern. Dredged material with chemical concentrations above the ML, equivalent to the highest AET for a range of biological indicators, is considered unacceptable for unconfined open-water disposal. The dredger, however, can conduct optional biological (bioassay) testing to establish the acceptability of the material. Dredged material with chemical concentrations below the SL is acceptable without confirming biological tests; SL is defined as 10 percent of ML, or average reference area concentration, whichever is higher, but never greater than the lowest AET for a range of biological indicators. Dredged material with chemical concentrations between the SL and ML always requires biological testing to establish itssuitability for disposal.

Discussion

Sediment quality measures or criteria can be useful tools in identifying contaminated sediments, but they may have to be applied differently to meet different uses or needs. For example, a criterion developed to indicate a "no effect" concentration might be very useful in monitoring disposal sites, but might have to be used with some sort of application factor to be administratively acceptable as a target concentration in the cleanup of a waste site. Many of the sediment quality measures discussed here have a "built-in" application factor, e.g.: upper and lower confidence limits in interim criteria derived through the EP approach; high and low AETs for a range of biological effects indicators; or different endpoints (or use of different species) in a sediment bioassay.

As noted earlier, sediment quality measures may consist of sediment concentrations for specific chemical contaminants, or may take a form which more readily addresses chemical mixture effects. Methods which generate chemical-specific values are the equilibrium partitioning, water quality criteria, screening level concentration, apparent effects threshold, and—in one type of application—the sediment quality triad. Approaches which give rise to measures reflecting chemical mixture effects are the sediment bioassay, infauna community structure, and the sediment quality triad; these generate toxicity hits, community structure parameters such as diversity or abundance, or area of triangles formed from RTR values, respectively. Chemical-specific methods which incorporate bioassays and/or community structure, e.g. the apparent effects threshold, also take chemical mixture effects into account, but their use in this regard is recommended only in conjunction with one of the non chemical-specific methods.

The relevance of specific assessment methods to specific management needs can be discussed in terms of three issues, 1) usefulness for assessments, 2) usefulness for deciding on management actions, and 3) cost. This has been attempted in Table 2, which is presented as a strawman for future discussion by parties involved in regulatory and technical aspects of contaminated sediment issues. The distinction between chemical- specific and non chemical-specific measures of sediment quality is important in conducting assessments and in selecting management actions. Methods which generate chemical-specific measures might be applicable to assessment, monitoring, and remediation situations where a known chemical(s) is the culprit, whereas methods generating non chemical-specific measures would be appropriate for situations where mixtures of unknown (or partially unknown) chemicals are suspected. Management actions appropriate for non chemical-specific impacts might emphasize removal or capping, while chemical-specific impacts could additionally be treated through regulatory chemical-specific source controls.

Some methods lend themselves to application over a broad area. These should be considered for comparative assessments of sites in different water segments (see under 1. B. in Table 2). On the matter of cost, methods involving labor-intensive taxonomic analyses would be the most expensive (see 3. in Table 2). They are, however, the most satisfying methods in that they demonstrate real-world impacts on biota, rather than inferring field impacts based on laboratory tests (e.g. bioassays) alone.

The evaluation of sediment contamination is often carried out through a tiered approach involving a number of separate methods. For example, the U.S. Army Corps of Engineers (Francingues et al., 1985) and the U.S.-Canada International Joint Commission (IJC, 1982) begin the evaluation of a dredge site by considering existing historical information and the physical constitution of the sediment (e.g., percent fines) for "reason to believe" that there is contamination. This is followed by a bulk chemical characterization of the dredge site against reference conditions (usually the disposal site). The final tier comprises biological tests (bioassessment) such as bioassays and contaminant bioaccumulation in tissues.

The primary concern of contaminated sediments is their effects on biota. This, coupled with an improved understanding in recent years of ways, or methods, to assess these effects, argues for emphasis on biological methods in a decision making framework. A possible tiered approach of this kind is depicted in Figure 1. It begins with a screening of chemicals for which equilibrium partitioning-based criteria are available, in order to identify those (if any) exceeding the criteria. For sediment "failing" this first tier, source control of specific responsible chemicals should be initiated (if relevant), and the need to remediate the contamination should be evaluated. Such evaluation would always take into account factors such as designated use of overlying water and costs. Following successful remediation, if that option was chosen, further tests which consider chemical mixture effects may be warranted.

Sediment passing Tier I would be subjected to a suite of sensitive sediment bioassays representing a diversity of taxonomic groups—Tier II. This ensures that the assessment approach is environmentally conservative, or protective. The bioassays should be standardized and relatively inexpensive, in addition to being sensitive to contaminants. Sediments passing Tier II would require no further action or cost. For sediments failing Tier II, any available site-specific information that might shed light on possible type or causes of "suspected" contamination should be evaluated—Tier III. This step examines for contamination by a known chemical(s) for which EP-based criteria are not yet available. At the discretion of the regulatory manager or potentially responsible party, further site-specific information can be obtained through sampling and subsequent analyses. If there is sufficient evidence that a known chemical(s) is the culprit, appropriate chemical-specific source controls should be instituted (if relevant), and the need to remediate contamination evaluated. If a specific chemical is not indicted, or following management action in the alternate case, it will be necessary to employ further bioassay tests and/or another technique which considers chemical mixture effects—Tier IV. Sediment passing this last tier would not warrant remediation (or further remediation as the case may be). For sediment which is contaminated, i.e. not passing Tier IV, toxicity-based source controls should be initiated (if relevant), and the need to remediate contamination evaluated.

Acknowledgements

Much of the information in this paper was compiled while one of the authors, M. Kravitz, was working at Battelle Ocean Sciences under Contract No. 68-03-3319 to the Environmental Protection Agency, Office of Marine and Estuarine Protection.

References

Boesch, D.F. 1977. Application of numerical classification in ecological investigations of water pollution. Office of Research and Development, U.S. Environmental Protection Agency Report EPA- 600/3-77-033. Corvallis,OR.

Chapman, P.M. 1986. Sediment quality criteria from the sediment quality triad: an example. Environ. Tox. Chem. 5:957-964.

Chapman, P.M., R.N. Dexter, and E.R. Long. 1987. Synoptic measures of sediment contamination, toxicity and infaunal community composition (the Sediment Quality Triad) in San Francisco Bay. Mar. Ecol. Prog. Ser. 37:75-96.

Chapman, P.M. 1987. Marine sediment toxicity tests, pp. 391-401 *In* J.J. Lichtenberg, F.A. Winter, C.I. Weber, and L. Fradkin (eds.) Chemical and Biological Characterization of Sludges, Sediments, Dredge Spoils, and Drilling Muds, ASTM STP 976. American Society for Testing and Materials, Philadelphia.

EPA. 1977. Guidelines for pollutional classification of Great Lakes harbor sediments. EPA Region V, Chicago, IL.

EPA. 1988. Interim sediment criteria values for nonpolar hydrophobic organic contaminants. SCD No. 17. Office of Water Regulations and Standards Criteria and Standards Division, Washington, DC.

Environmental Protection Agency (EPA)/Corps of Engineers (COE). 1977. Ecological evaluation of proposed discharge of dredged material into ocean waters; Implementation Manual for Section 103 of Public Law 92-532 (Marine Protection, Research, and Sanctuaries Act of 1972).

U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Francingues, N.R., Jr., M.R. Palermo, C.R. Lee, and R.K. Peddicord. 1985. Management strategy for disposal of dredged material: contaminant testing and controls. Miscellaneous Paper D-85-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

International Joint Commission (IJC). 1982. Guidelines and register for the evaluation of Great Lakes dredging projects. Report of the Dredging Subcommittee to the Water Quality Programs Committee of the Great Lakes Water Quality Board, International Joint Commission, Windsor, Ontario.

Lamberson, J.O. and R.C. Swartz. 1988. Use of bioassays in determining the toxicity of sediment to benthic organisms, pp. 257-279 *In* M.S. Evans (ed.) A Great Lakes Focus.

Long, E.R. 1983. A multidisciplinary approach to assessing pollution in coastal waters, pp. 163-178 *In* Proceedings of the Third Symposium on Coastal and Ocean Management. ASCE., San Diego, California June 1-4, 1983.

Long, E.R. 1985. Status and trends in sediment toxicity in Puget Sound. Conference Record Oceans 85: 919-925. MTS/IEEE.

Long, E.R. and P. M. Chapman. 1985. A Sediment Quality Triad: measures of sediment contamination, toxicity and infaunal community composition in Puget Sound. Mar. Pollut. Bull. 16:405- 415.

Neff. J.M., D.J. Bean, B.W. Cornaby, R.M. Vaga, T.C. Gulbransen, and J.A. Scanlon. 1986. Sediment quality criteria methodology validation:calculation of screening level concentrations from field data. Final Report prepared by Battelle for U.S.

Environmental Protection Agency Criteria and Standards Division under Work Assignment 56, Task IV. Washington, DC.

PTI. 1988a. Draft contaminated sediments criteria report. Prepared for Washington Department of Ecology. PTI Environmental Services, Bellevue, WA.

PTI. 1988b. Sediment quality values refinement: Task 4— Evaluation of

PSDDA sediment quality values. Draft Report prepared for U.S. Environmental Protection Agency Region X, Office of Puget Sound under EPA Contract No. 68-02-4341 to Tetra Tech, Inc. PTI Environmental Services, Bellevue, WA.

PTI and Tetra Tech. 1988. Elliott Bay action program: analysis of toxic problem areas. Draft Report. Prepared for U.S. Environmental Protection Agency Region X, Office of Puget Sound. PTI Environmental Services and Tetra Tech, Inc., Bellevue, WA.

Sheehan, P.J. 1984. Effects on community and ecosystem structure and dynamics, pp. 51-99 *In* P.J. Sheehan, D.R. Miller, G.C. Butler and Ph. Bourdeau (eds.) Effects of Pollutants at the Ecosystem Level.

Swartz, R.C., W.A. DeBen, J.K.P. Jones, J.O. Lamberson, and F.A. Cole. 1985a. Phoxocephalid amphipod bioassay for marine sediment toxicity, pp. 284-307 *In* R.D. Cardwell, R. Purdy, and R.C. Bahner (eds.) Aquatic Toxicology and Hazard Assessment: Seventh Symposium, ASTM STP 854. American Society for Testing and Materials, Philadelphia.

Swartz, R.C., D.W. Schults, G.R. Ditsworth, W.A.DeBen, and F.A. Cole. 1985b. Sediment toxicity, contamination, and macrobenthic communities near a large sewage outfall, pp. 152-175 *In* T.P. Boyle (ed.) Validation and Predictability of Laboratory Methods for Assessing the Fate and Effects of Contaminants in Aquatic Ecosystems, ASTM STP 865. American Society for Testing and Materials, Philadelphia.

Tetra Tech. 1985. Commencement Bay nearshore/tideflats remedial

investigation. Report prepared for the Washington State Department of Ecology and U.S. Environmental Protection Agency. Tetra Tech, Inc., Bellevue, WA.

Tetra Tech. 1986. Development of sediment quality values for Puget Sound. Final Report prepared for Puget Sound Dredged Disposal Analysis and Puget Sound Estuary Program. Tetra Tech, Inc., Bellevue, WA.

Tetra Tech. 1987. Commencement Bay Nearshore/Tideflats Feasibility Study: development of sediment criteria. Final Draft Report. Prepared for the Washington State Department of Ecology and U.S. Environmental Protection Agency. Tetra Tech, Inc., Bellevue, WA. Washington, H.G. 1984. Diversity, biotic and similarity indices. A review with special relevance to aquatic ecosystems. Water Res. 18:653-694.

Williams, L.G., P.M. Chapman, and T.C. Ginn. 1986. A comparative evaluation ofmarine sediment toxicity using bacterial luminescence, oyster embryo and amphipod sediment bioassays. Mar. Env. Res. 19:225-249.

Zarba, C.S. 1987. Status of the U.S. EPA's sediment quality criteria development effort, pp. 13-17 *In* J.J. Lichtenberg, J.A. Winter, C.I. Weber, andL. Fradkin (eds.) Chemical and Biological Characterization of Sludges, Sediments, Dredge Spoils, and Drilling Muds, ASTM STP 976. American Society for Testing and Materials, Philadelphia.

Use Determination and Benefit Valuation in Boston Harbor Management

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Abstract

It is generally acknowledged that Boston Harbor is one of the most severely stressed estuarine environments in the United States. Plans to reduce pollutant inputs into the harbor are now under review and will be carried out under a schedule determined by the Federal Courts. Those plans will result in the construction of a set of environmental control facilities whose cost will reach well into the billions of dollars. This paper is an initial attempt to describe the value of benefits expected to result from those activities. The paper concludes that uncertain, but likely conservative, estimates suggest that annual additional benefits totaling $67 million can be expected from a cleaner harbor environment.

Introduction and Background

The environmental problems facing the Boston Harbor and Massachusetts Bay (BH/MB) system derive from several sources. Boston is in the midst of a rather remarkable period of growth. Unemployment rates hover around three per cent, while annual appreciation rates for eastern Massachusetts real estate approached 40% for 1985. One of the consequences of such an economy has been unprecedented development in the coastal zone, particularly in Boston Harbor. Indeed, over two billion dollars of new waterfront construction has taken place over the past decade.

Traditional harbor uses, such as fishing, shellfishing and maritime transport, have been replaced, to rather remarkable degrees, with non water-dependent development. Residential buildings and hotel/shopping complexes have begun to dominate a waterfront once dependent on lobstering, fish processing and maritime terminals. The number and size of new waterfront construction has placed significant pressures on an already stressed environment.

Harbor and inland development has strained particularly the region's archaic and inadequate municipal and industrial waste systems. Boston Harbor is the sink for the waste produced by nearly three million residents of 43 cities and towns in eastern Massachusetts (nearly one-half the population of the state). Over 5,000 industries discharge into the system. These wastes are presently released into the harbor via discharges from two primary treatment facilities, in the form of wastewater effluent and sludge, and untreated discharges from about 90 currently operating combined sewer overflows (CSOs). The two treatment plants, owned and operated by the Massachusetts Water Resources Authority, dump nearly one-half million gallons of primary treated sewage and sludge each day. These volumes increase dramatically during storms when untreated sewage is allowed to flow directly into the harbor through the CSO system (there are also significant dry weather CSO discharges of untreated sewage into the harbor).

Poor wastewater management practices have led to several environmental and resource problems. Elevated levels of poly- chlorinated biphenyls (PCBs) and polynuclear hydrocarbons (PAHs) have been measured at numerous sites in the harbor. Levels of PAHs in certain areas are among the highest known to exist worldwide. Fin rot and neoplastic liver lesions in winter flounder and black gill disease in lobster have been identified. The Massachusetts Department of Environmental Quality Engineering (DEQE) has classified all shellfish beds in Boston Harbor as either closed or restricted to commercial harvesting. All commercially harvested shellfish must go through a 48 hour depuration process before being sold. Ambient levels of certain toxic metals have been found to far exceed national clean water standards. Beaches in an around Boston Harbor are regularly closed to swimming because indicator colloform bacteria levels exceed health standards.

These problems have not gone entirely unrecognized by either state or national environmental managers. In order to attempt a resolution to these problems between 3 and 10 billions of dollars will be spent to plan for and build new wastewater controls. Existing calculations suggest that individual households within the MWRA district can expect annual water and sewer fees to escalate dramatically over the next fifteen years, likely reaching levels in excess of $1,400. Given such remarkable expenditures a reasonable person might question what benefits can be expected to accrue to offset such costs. That is the question that focuses the work that has generated these initial results.

Use Determination

In order to effectively answer such a question it is first necessary to offer a characterization of the harbor and of the uses reliant on a healthy harbor environment.

The harbor itself is relatively small and shallow, with more than three-quarters of the harbor waters less than four meters deep. The harbor is described as an estuary fed by three major tributaries—the Mystic, Charles and Neponset Rivers. However, nearly one-half of the fresh-water input flows from the MWRA wastewater stream.

The port of Boston is the largest seaport in New England offering more than 150 piers, wharves and terminals linked to its two major shipping channels. The harbor itself encloses more than 180 miles of shoreline, including 30 islands. This shoreline is surprisingly undeveloped, with more than 40% remaining as open space. Harbor waters serve as an important recreational resource for the region with more than 160,000 people using the 30 or so saltwater beaches during a summer's day.

The BH/MB systems further provides important fisheries stocks and spawning environments for a wide-range of commercial and recreational fisheries. Lobstering and shellfishing are both particularly long-standing industries in the area. Any consideration of social use of the harbor must also consider some measure of instrinsic value. Boston Harbor is a rich contributor to the cultural and social history of the region, and its continued degradation has been the source of significant concern among area residents.

Benefit Valuation

Once the different uses of Boston Harbor/Massachusetts Bay have been identified, the next step is to determine how the environment will be improved by the upgrading of the municipal sewage treatment system, elimination of sludge disposal, stricter control of combined sewer overflows (CSOs), and any other pollution control programs designed to reduce the quantity of waste reaching the harbor/bay environment. Unfortunately, our current lack of knowledge concerning the sources and fates of contaminants make this calculation impossible at this time. We are only beginning to develop an understanding of the types of pollutants entering the water, let alone how these pollutants impact the environment of BH/MB. There is an active research program underway to begin to improve our knowledge of these areas, but until then, valuation of the improvements from the implementation of pollution control programs involves considerable uncertainty.

If environmental impact information were available, a connection would then have to be drawn between the changes in the natural environment and the changes in the capacity of different uses. For example, better control of CSOs is likely to result in fewer beach closings during the summer. Such an impact translates into an expansion in the supply of beaches, which can then be valued as discussed below. Alternatively, cleaner harbor waters may result in the expansion of certain fish stocks or a reduction in the incidence of cancerous tumors found in flounder. This may lead to additional recreational fishing capacity, the value of which can also be quantified. Obviously, as long as the impact of pollution control on the environment remains highly uncertain, the impact of resulting changes in the environment on economic uses also remains uncertain. However, given all this uncertainty a range of impacts on harbor uses of a cleaner harbor can be hypothesized and tentative values assigned to these impacts.

Due to the limited scope of this paper, the values of harbor uses discussed are based on other studies of different aspects of the harbor clean-up projects. In many ways these are incomplete and all are based on many simplifying assumptions. The additional use value estimates are based on assumed environmental improvements resulting from expanded CSO control and the upgrading of primary treatment and addition of secondary sewage treatment to the current Boston Harbor sewage treatment facilities. Much of the data is taken from (Meta Systems Inc., 1984) which in turn is based on the pollution control options outlined (USEPA, 1983), (Metcalf and Eddy, 1982) and (Metropolitan District Commission, 1982).

Table 1 documents the existing estimates of use values and the many uses for which we have no current value estimates (signified by a ?). Column 1 lists the estimated increase in value of the respective use that might result from the increased control of CSOs and the upgrading of primary treatment and the addition of secondary treatment systems to the harbor. Column 2 gives any existing estimates of total current use value given existing water quality.

The reader is cautioned to interpret these figures as very rough estimates to give an initial idea of the order of magnitude involved. There are a number of assumptions which apply to each estimate including what level of pollution control will be undertaken, the likely impact of this control on water quality, and the impact of improved water quality on the value of the respective uses. Due to length restrictions, these assumptions cannot be detailed in this paper, but given the high degree of uncertainty surrounding the operation of the BH/MB ecosystem, the estimates are likely to be highly sensitive to the assumption specified.

Increased Use Value Estimates for Selected Uses

The major harbor uses listed in Table 1 are those described earlier in this paper. In the remaining section of this paper the nature of the available estimates will be briefly described and the need for further information documented.

Beaches

The additional value of beach use ($25 million) is derived from (Meta Systems Inc., 1984) and inflated to 1987 dollars. It is assumed that most of this benefit will be a result of stricter controls on CSOs, since these have the most severe shoreline impact. Ideally this value should measure the willingness to pay of area residents for the additional beach use, acquired largely through reduced beach closing, that is likely to become available after the controls are in place. This is difficult to determine since onewould like to know how perceptions of improved water quality will effect demand for beach use. The main benefits from an increase in beach supply because of fewer closings will be the cost savings to individuals from not having to travel to equal quality beaches located further away; the value of beach swimming for those individuals who cannot afford to travel to substitute beaches, but who are not currently using local beaches because of the pollution levels and who would begin using them once pollution was reduced; and the additional value of the cleaner beach environment to those people currently using the beach.

However, measuring these benefits would require a series of contingent valuation studies to determine the social value of different qualities of beach use. Such studies were beyond the scope of the Meta Systems study. Thus, the reported estimate is much rougher and based on beach attendance figures from 1975 and projected increase in beach use as measured by additional beach days per capita made available by reduced closings. The value of an additional beach day was taken from other national studies of beach valuation. Because of the methodology used, it is impossible to determine if this is likely to be an under or over estimate of the true value of additional beach use.

Recreational Fishing and Boating

Improvements in water quality will lead to additional willingness to pay for recreational boating and fishing on the part of current users as well as additional use. The estimate of additional use value of boating reported here does not include the additional value placed on cleaner water by current users. It is based on an assumption that there will be a 20% increase in demand for recreational boating and fishing days and this increase in quantity demand is multiplied by recreational user day values as determined in other national studies.

The value of increased recreational finfishing does not assume any stock change as a result of the improved water quality, since current information does not allow for determining whether stocks will rise (because the cleaner water reduces incidence of fish cancers and increases fish population) or fall (because of the drop in nutrient loading in the water may serve as a major food source).

Recreational shellfishing does not currently take place in the area, but it may begin after the pollution controls take effect. Therefore, instead of assuming no use, we have left the impact uncertain.

Commercial Fishing

The effect of improved water quality on commercial finfish and lobster stocks is highly uncertain. Currently commercial fishing for finfish is so highly restricted in harbor waters that catch is negligible. This is determined by management goals and whether it change with cleaner harbor waters is uncertain and depends on what would happen to fish stocks. The effect of cleaner harbor waters on lobster stocks is uncertain—some have predicted a reduction in stocks and others an increase. The value of current lobster catch from the harbor area is $3.2 million. The gain in the value of additional shellfish ($700,000) assumes pollution control will result in an opening of 60 percent of the currently closed beds and that the harvest from these beds will still require depuration.

Option and Existence Value

These concepts relate to two benefits from improved water quality that are quite difficult to quantify. Option value is the willingness to pay of the general population to ensure their continued, or possible future, access to harbor resources. It may also include the wish to leave a certain minimum quality of the resource to future generations. This demand for a cleaner harbor is not reflected in the market for various harbor uses, but can be a large benefit from achieving a cleaner harbor/bay ecosystem. Existence value is the willingness to pay for the knowledge that a clean harbor will continue to exist, regardless of whether one is planning on using its resources or not.

The estimate given in Table 1 is simply one-half the total of additional beach and recreation benefits. This is based on findings in other studies that indicate that such values are often of at least this magnitude. Further research would be needed in this area to provide a more accurate estimate. Given the possible magnitude of such an estimate, such research would seem to be justified.

Health

This estimate is likely to be quite conservative, since it is based only on reported medical cases that could be positively linked to harbor water contact. Since many of these cases are unreported and because the possibility of viral transmission in polluted waters is so little understood, this estimate is probably quite conservative.

The other uses listed in Table 1 may be important and might be substantially impacted by water quality. However, we currently lack data from which to determine even a rough estimate. Very little is known on how water quality interacts with the BH/MB ecosystem or how this ecosystem interaction translates into effects on human uses. Therefore, estimates of values in this area will have to await future research.

Conclusion

It is clear that much more research is needed to develop comprehensive estimates of the value of different harbor uses and of the increases in value that would result from cleaner harbor waters. The total of the rough estimates of gains in use value from pollution control is $67 million annually. However, this probably grossly underestimates the true number, since we do not have values for many important uses and most of the estimates for each use that we do have are quite conservative.

References

Meta Systems, Inc., "A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls," Office of Policy Analysis, U.S. EPA, Washington, D.C., 1984

U.S. EPA, "Analysis of the Section 301(h) Secondary Treatment Waiver Application for Boston Metropolitan District Commission," Office of Marine Discharge Evaluation, Washington, D.C., June 30, 1983.

Metcalf and Eddy, Inc., "Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I, Site Options Study," Metropolitan District Commission, Boston, MA, June, 1982.

Metropolitan District Commission, "Combined Sewer Overflow Project: Summary Report on Facilities Planning," Boston, MA, April, 1982.

Values of Harbor Uses
(in millions of 1987 dollars)

USE	ANNUAL ADDITIONAL USE VALUE after Secondary/CSO	CURRENT TOTAL USE VALUE
Beaches	25	?
Recreational		
Shellfishing	?	None Now
Finfishing	6	?
Boating	12	?
Commercial		
Shellfishing	0.07	1.3
Lobstering	?	3.2
Finfishing	?	Not Allowed
Private Charter Boats	?	?
Health	2	?
Non-Market		
Option, Existence Value	22	?
Ecological	?	?
Aquaculture	?	
Waterfront Development, Property Values	?	
Tourism and Travel	?	
TOTAL	app. 67	

Beyond Sewage Treatment Plants: Massachusetts' Efforts for Keeping Our Harbors Clean

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The Clean Water Act which was originally passed by Congress in 1972 was the result of a widespread recognition that existing waste disposal practices were leading to serious and widespread water pollution problems. The federal government, working with state authorities, embarked on a massive construction grants program using billions of dollars to bring local communities up to standardized treatment levels. Because of the magnitude and universality of the problems, initial efforts were prioritized to focus on the protection of surface drinking water supplies, which included primarily rivers and lakes. Coastal waters were not considered a priority because the evidence for contamination was comparatively less obvious and because many regulators, engineers, and scientists assumed that coastal waters had a large assimilative capacity for water-borne contaminants.

Amendments to the Clean Water Act in subsequent years attempted to refine and improve government efforts. A 1977 amendment perpetuated the concept of a large assimilative capacity in marine waters by allowing coastal communities with discharges to the ocean to apply for waivers to the existing requirement for secondary treatment if they could demonstrate that a reduced level of treatment would not have significant negative impacts on the marine environment. On the surface, this program, called 301(h) waivers, seemed a reasonable method for both reducing treatment costs and using the ocean's assimilative ability. The original intent by Congress was to provide a means of fiscal relief for small, isolated west coast communities where secondary treatment requirements would be a burdensome expense for a relatively small population and where the close proximity of deep water to the shoreline was expected to provide strongly dispersive conditions. In writing the legislation, however, the waiver process was opened to all coastal areas of the country, and consequently many municipalities, including many large east coast cities where near coastal waters are relatively shallow, jumped at the opportunity to reduce costs.

The application evaluation process for the waivers and the appeal procedures proved incredibly more complex and cumbersome for the Environmental Protection Agency (EPA) than they anticipated. Complexities arose from scientific uncertainties over the predicted impacts which were often supported by only limited data from a narrow period of time. The large number of applicants and the many volumes of supporting information seemed to overwhelm the ability of EPA to conduct timely substantive evaluations, and the subsequent appeals procedure for negative determinations has proven to be drawn out, filled with legal and scientific uncertainties, and has resulted in long delays in meeting the mandated treatment levels. Perhaps the most significant effects to emerge from this process are the acknowledgements that much is unknown about the physical, chemical, and biological factors that influence the marine ecosystem and that environmental damage to marine waters from past and ongoing discharge practices does exist, which has supported the strong doubts raised over the concept of assimilative capacity.

In Massachusetts eight coastal municipal facilities serving roughly 2 1/2 million people applied for waivers, including four of the largest discharges: Boston, Salem, Lynn, and New Bedford. Only two waivers were eventually granted including the City of Gloucester, a major commercial fishing center, which applied very early in the process and was reviewed before the scientific questions came to the forefront, and Cuttyhunk, a remote island with a low population, whose conditions met the original intent of the program. The other six have been denied, but two presently continue to pursue an appeal. The net result is that several of our large, important harbors continue to be extensively contaminated because of the delays in implementing treatment requirements. Frequently even the minimum primary treatment requirements have not been met. The National Oceanic and Atmospheric Administration (NOAA) has identified two harbors, Boston and Salem-Beverly, as the two most polluted in the nation, based on a sediment sampling study and benthic survey. While responsibility for the delay in treatment facilities is shared among federal, state, and local governments to varying degrees, the resulting effect is that full implementation of treatment requirements has not been accomplished and, while the planning process is well underway, treatment plant construction will not be achieved for at least another decade.

Increasing concern for the condition of the marine environment in Massachusetts began in the 1970s. As the result of a study by a special legislative commission, the Massachusetts legislature passed several acts in the 1970s which have come to be known as the Ocean Sanctuaries Acts and which constitute a unique program in the nation. The intent of the legislature was to protect the marine ecosystem and the beaches which support two major industries in the state: fishing and tourism. While much of the attention focused on potential effects from off-shore oil and gas drilling, there was also concern for the effects of toxics and wastes from land-based sources. The major actual effect of the Ocean Sanctuaries Acts has been to prohibit new and expanded discharges to marine waters for most of the state, which has forced state regulatory agencies and local governments to seriously consider alternatives, which have included expanded efforts to limit flows by controlling inflow and infiltration into sewer lines and to examine seriously land disposal options for treatment plant effluents. The benefits and detriments of the legislation continue to be debated at all levels of government.

Evidence from many sources points to increasing environmental damage in our near coastal waters. As mentioned earlier, NOAA has conducted sediment sampling and benthic surveys in harbors around the country and found widespread contamination. Data collected for the 301(h) waivers toxics documented contamination and oxygen depletion at existing discharges locations. Fishing stocks have shown sharp decreases, which could be a result of overfishing and other causes, but physical evidence has also accumulated for an increase in fish disease including liver tumors and fin rot in fish caught near urban coastal areas including Boston and Salem/Beverly harbors, with a suggestion for a strong link to contaminants. Toxic red tides have also shown an apparent recent increase in Massachusetts waters and questions arise concerning a possible connection with increased nutrient input. Investigations associated with Superfund efforts have identified New Bedford Harbor as one of the top ten contaminated sites in the country due to PCB contamination, which has resulted in the closure of the entire harbor and large areas beyond to fishing and shellfishing. Using current health standards there has also been a near exponential increase in closures of shellfish beds in Massachusetts and even new closures of swimming beaches. Although the significance of the information in relation to health impacts has not been agreed upon, data from statewide studies by the Massachusetts Division of Marine Fisheries and by an EPA-sponsored investigation on the safety of consuming seafood from Quincy Bay in Boston Harbor indicates that there is evidence for accumulation of PCBs by lobsters. Plastics pollution has been well documented through beach cleanups and clearly identified as having impacts on marine mammals, seabirds, fish, and sea turtles. Together, this provides evidence that man's activities are exceeding whatever capacity our near coastal waters have for absorbing our cast off wastes.

While our track record to date on sewage treatment facilities is not good and can be documented, we have also become aware that other sources are important contributors to the pollution problem and may have been previously masked by treatment plant discharges. Evidence collected through state and local efforts have identified combined sewer overflows, failing septic systems, stormwater runoff, rivers, and illegal sewage discharges from boats, all collectively often referred to as non-point sources, as sources of contaminants in marine waters. This is especially evident on Cape Cod, Massachusetts, where there has been a recent expansion of shellfish closures and bathing beach closures, even though there are no point discharges from treatment plants. At the federal level, amendments to the Clean Water Act in 1987 established a program to address Non-Point pollution, and, working together, Massachusetts regulatory agencies and interested groups have now developed the framework for proposed program, which has been submitted and is currently undergoing review for approval by EPA. Rather than create more regulatory bureaucracy, the program aims to succeed through a networking approach with existing federal, state, and local agencies as the enforcers of new requirements. Through its participation in the regular statewide environmental review process, the Massachusetts Coastal Zone Management (MCZM) program, for example, contributes by raising questions on non-point problems for proposed projects in the coastal zone and alerting the Non-Point program coordinators to particular projects of concern.

Other regulatory changes at various levels have begun to address non-point issues. For the first time, NPDES discharge permits for treatment plants which are issued jointly by EPA and the Massachusetts Department of Environmental Quality Engineering have, for the last year, included requirements for controlling and monitoring pollution from combined sewer overflows. Similar permits are being contemplated for stormwater runoff that discharges at a point location, although these are probably so numerous that only the largest ones and those that discharge into sensitive areas (drinking water supplies, swimming areas, and shellfish beds) will receive scrutiny. The placement and construction of septic systems is governed by the state sanitary code known as Title V, which took effect in July 1977. The guidelines in Title V are presented as minimum requirements, and local communities can and have enacted more stringent regulations. As the knowledge of impacts from failing septic systems has increased, there has been widespread recognition that revisions to Title V are necessary, and a task force has been formed in the state environmental agencies to formalize these changes on a statewide basis. Evidence, particularly from harbors on Cape Cod, indicates that sewage discharges from boats may be a significant source of contamination. The issues related to boat discharges are complex due to regulatory, jurisdictional, and technical problems and another task force with federal, state, and local representation is addressing the problem.

Much of the recent concerns and frustrations over coastal contamination has resulted from the inability to identify the sources, the fates, and the effects of the pollutants that are being continuously discharged in large quantities. EPA and MCZM have developed jointly a Bay's Program for Buzzards Bay, Massachusetts as part of a national program. This project has included efforts to identify sources of contaminants and to focus research and demonstration projects on gathering better data and on attempts to remedy the identified problems. A similar proposal is currently being developed for a Massachusetts/Cape Cod Bays Program. In addition, the Massachusetts CZM office, working together with marine scientists at local institutions, has identified the need for and is in the process of developing a statewide research and monitoring program for coastal waters in order to improve our knowledge of the conditions and the changes occurring in the entire marine ecosystem. All of the mentioned programs together with a few other contributions from other agencies will contribute to a loosely structured but centrally coordinated program which should provide us with increased information and understanding of our coastal waters. With increasing pressures for commercial and residential development along our harbors and ports, and with the recognition of the impacts of development and the important role of harbors and estuaries in the marine ecosystem, water quality become critically important in the planning process and an important resource to preserve.

STEPS IN MONITORING THE IMPACTS OF SEWAGE POLLUTION IN BOSTON HARBOR

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Problem Setting

Boston Harbor is a relatively shallow complex of bays and tidal estuaries covering 47 square miles located on the western edge of Massachusetts Bay (Figure 1). The Massachusetts Water Resources Authority (MWRA) is the major discharger to Boston Harbor. The MWRA discharges approximately 450 million gallons of sewage effluent and 50 dry tons of sewage sludge to the harbor every day. Combined sewer overflows (CSOs) release ten billion gallons of effluent every year, about six percent of the effluent flow. The MWRA is currently designing facilities that will remove the sludge from the harbor in 1991 and effluent in 1996. CSO treatment plans are also being developed. These facilities will cost MWRA ratepayers more than six billion dollars. To evaluate the effectiveness of these programs, the MWRA is developing a monitoring program that will document the improved environmental quality of Boston Harbor resulting from these new facilities.

Monitoring Plan Framework

In developing these monitoring programs MWRA is following an ocean dumping site monitoring framework developed for the U.S. Environmental Protection Agency (Connor et al., in press). This monitoring guidance recommended a stepwise approach to an effective monitoring program. MWRA has slightly modified this approach to include the following steps:

1. Develop a conceptual framework for the program using existing information about the site and waste characteristics.
2. Develop clear objectives for the program.
3. Formulate specific null hypotheses based on predicted impacts of the "clean-up" program.
4. Group the null hypotheses into tiers to provide cost-effective and efficient monitoring.
5. Select the monitoring parameters and methods necessary to verify the null hypotheses.
6. Determine the natural variability of the parameters to be monitored within the natural system.
7. Design the sampling program by selecting the number of stations and replicates that will allow detection of changes in parameter values of significant to harbor managers.

Application of the Monitoring Framework to Boston Harbor

Most literature describing monitoring programs emphasizes the scientific aspects of program design, yet for effective coastal management the institutional aspects are equally important. This paper discusses the institutional questions surrounding the design of MWRA's monitoring program for microbial contamination. Institutional issues are particularly important in the first three steps: conceptual framework, clear objectives, and null hypotheses.

This paper specifically addresses microbial contamination because closed beaches and shellfish beds are the most visible consequences of the sewage pollution entering Boston Harbor. These closures are regulated by abundances in coastal waters of bacteria found in high concentrations in domestic sewage, primarily fecal coliforms, although current EPA guidelines call for the use of a different indicator group, enterococci, for regulating recreational waters.

Conceptual framework

To develop a conceptual framework for monitoring microbial contamination in Boston Harbor, existing information about the characteristics of the site and the waste being discharged is used to predict the potential for effects from waste disposal. When possible, it is useful to develop mass loading estimates for the contaminants being monitored (Table 1). Such mass loading estimates must also be combined with quantitative or qualitative models of the fate and transport of the contaminant. For example, Table 1 suggests that CSOs are the major concern for fecal coliform pollution. However, water quality modeling shows that most of the fecal coliform discharges from CSOs are not transported beyond the Inner Harbor where there are no beaches nor shellfish beds (Hydroscience, 1971). A microbial monitoring program might then treat the Inner Harbor simply as a separate source that integrates most of the CSO input.

Another important factor to consider in the design of monitoring program is information available from other ongoing programs. Few monitoring programs exist in isolation. For instance in Boston Harbor, microbial monitoring data are being collected simultaneously by several agencies (Table 2). While they are not absolutely relevant to MWRA's monitoring needs, these ancillary data do provide useful information in determining the impact of MWRA's discharges.

Table 1. Sources of Freshwater and Fecal Pollution to Boston Harbor

Source	Flow (10^9 gallons/yr)	% Contribution	Fecal Coliforms (No./yr)	% Contribution
MWRA Wastewater				
Deer Island WWTP	117	43	$3x10^{15}$	<1
Nut Island WWTP	47	17	$4x10^{13}$	<1
Combined Sewer Overflows	10	4	$3x10^{17}$	80
Sludge	0.7	<1	$2x10^{14}$	<1
Other Sources				
Storm Runoff	8	3	3x1016	9
Rivers	88	32	3x1016	9

The purposes of these other monitoring efforts are to make binary decisions regarding compliance with water quality standards or discharge permits, but little attempt has been made to relate the distribution of fecal indicator bacteria in Boston Harbor following wet or dry weather to specific discharges. To assist in developing our monitoring program, we are attempting to compile all available bacterial water quality data, and to analyze it with relation to climatological and treatment plant/CSO records. This analysis provides the conceptual framework for developing monitoring objectives and hypotheses for testing.

Table 2. Current Microbial Monitoring in Boston Harbor.

AGENCY/PURPOSE	LOCATION	FREQUENCY	INDICATOR
Div. Marine Fisheries/ Shellfish bed status	Mid-Harbor Clam beds Clams	Biweekly? Post-rain	Fecal Coliforms Total Coliforms
Metropolitan District Commission/ Beach status	Beaches Enterococci	Weekly	Fecal Coliforms
Quincy Board of Health/ Beach status	Beaches	Weekly	Fecal Coliforms Total Coliforms
Winthrop BOH/ Beach status	Beaches	Weekly	Fecal Coliforms Total Coliforms
MWRA Sewerage/ Permit compliance	Effluent	Daily	Fecal Coliforms Total Coliforms

Monitoring objectives

All marine discharge monitoring programs are ultimately designed to ensure that waste disposal does not adversely affect human health or the marine environment. This intent can be broken down into two categories: to provide relevant information needed (1) to evaluate compliance with permit conditions and (2) to determine the impacts of the discharge.

MWRA's discharges are regulated in the same way as all municipal discharges, through a permit under the National Pollution Discharge Elimination System (NPDES). MWRA's NPDES permit contains standards for the concentrations of fecal and total coliforms that may be discharged. Data to demonstrate compliance with these permitted concentrations are collected daily.

In the past permit compliance has been all the monitoring required by dischargers. However, given increasing public concern over the impact of MWRA's discharges on the harbor, it is important that a monitoring program be developed to verify that permit compliance is sufficient to protect the environment. We anticipate new permit requirements that would result in monitoring to determine more fully the kinds of impacts that MWRA discharges are causing on the environment. Perhaps even more important than regulatory concerns are the interests of users of the harbor and MWRA ratepayers that the environmental benefits of a multi-billion dollar investment in new facilities are well documented.

Null hypotheses

Monitoring programs can be designed most effectively if they borrow the concept of hypothesis testing from scientific experimentation. Implicit in the concept of an experiment is a question or hypothesis that is being evaluated. A monitoring program focused on answering specific questions or testing hypotheses concerning compliance with permit conditions and potential impacts of disposal of wastes into coastal waters will be designed quite differently than a program that is viewed as simple data collection (Green, 1979).

The challenge in framing hypotheses is to translate general statements of public concern to specific, testable statements (Table 3). Few public concerns can be fully answered by a monitoring program. Even the assumptions on which a discharge permit are based can be difficult to verify, but the major thrust of these assumptions can generally be addressed. Other problems arise due to questions of spatial and temporal variability and the desire for completeness in a monitoring program. In this example, it is known that the most contaminated conditions are associated with rainfall, but recreational use is greatest during sunny weather in the summer. Testing of hypotheses associated with spatial and temporal variability must often precede monitoring to respond to public environmental concerns.

Finally, monitoring program design is constrained by the scientific uncertainty that surrounds most aspects of environmental monitoring. For instance, there is still no consensus in microbial monitoring as to which microbial indicators are most protective of bathers and shellfish consumers. At some point, these concerns are overarching hypotheses that are more appropriate for national research programs. MWRA is considering a monitoring strategy that includes some exploratory sampling for enteric pathogens in addition to the common bacterial indicators, and evaluating the importance of sediments as a long-term source of pathogens.

Table 3. Sample monitoring hypotheses

Public question
When will it be safe to swim in the harbor?

Implicit permit compliance hypothesis
If effluent and CSO discharges are in compliance, then beach and shellfish beds will present no public health risks to users.

Site-specific testable hypotheses
Storm sewers are not responsible for beach closures.
Nut Island discharges do not cause beach closures outside a 4-km radius.
Deer Island discharges do not cause shellfish closures outside a 6-km radius.
CSO-caused exceedances of water quality standards are limited to a 1-km radius.

Meta-level hypotheses
There is a significant relationship between rainfall and beach closures.

Fecal coliforms and enterococci are appropriate indicators for public health risks of pathogen contamination of swimming beaches or shellfish beds.

Discussion and Conclusions

Coastal monitoring will assume increased importance as the population of coastal communities increases. Municipal sewage treatment plants are a highly visible source of coastal discharges and will come under detailed public scrutiny even if their operations are fully in compliance with existing permits. In the summer of 1988 sludge discharges off New York were blamed for beach closures and shellfish diseases from Rhode Island to Maryland.

Simply to demonstrate that the waste discharged complies with the NPDES permit limits will no longer be sufficient. Impact assessment will replace compliance assessment as the centerpiece of the monitoring programs developed by coastal dischargers. The public will demand that the dischargers "prove" that their effluents are not harming the coastal environment.

This linkage between management decisions, public concerns, and monitoring programs will result in a political process requiring several iterations of public input. Because the public is so concerned with process, a simple reporting of the results as is the practice for compliance assessment is no longer sufficient. Agencies will need to provide sufficient budgets for a detailed analysis of their data and the clear presentation of the data to the public.

References

Connor, M.S., C.E. Werme, P.D. Boehm, and J.M. Neff. in press. A Decision Framework for Site Management and Site Monitoring at Ocean Dumping Sites. International Ocean Dumping Symposium Series.

Green, R.H. 1979. Sampling design and statistical methods for environmental biologists. John Wiley and Sons, New York, 257 pp.

Hydroscience, Inc. 1971. Development of Water Quality Model of Boston Harbor. Commonwealth of Massachusetts Water Resources Commission, Boston, MA, 173 pp.

Disclaimer

This article represents the opinions and conclusions of the author and not necessarily those of the MWRA.

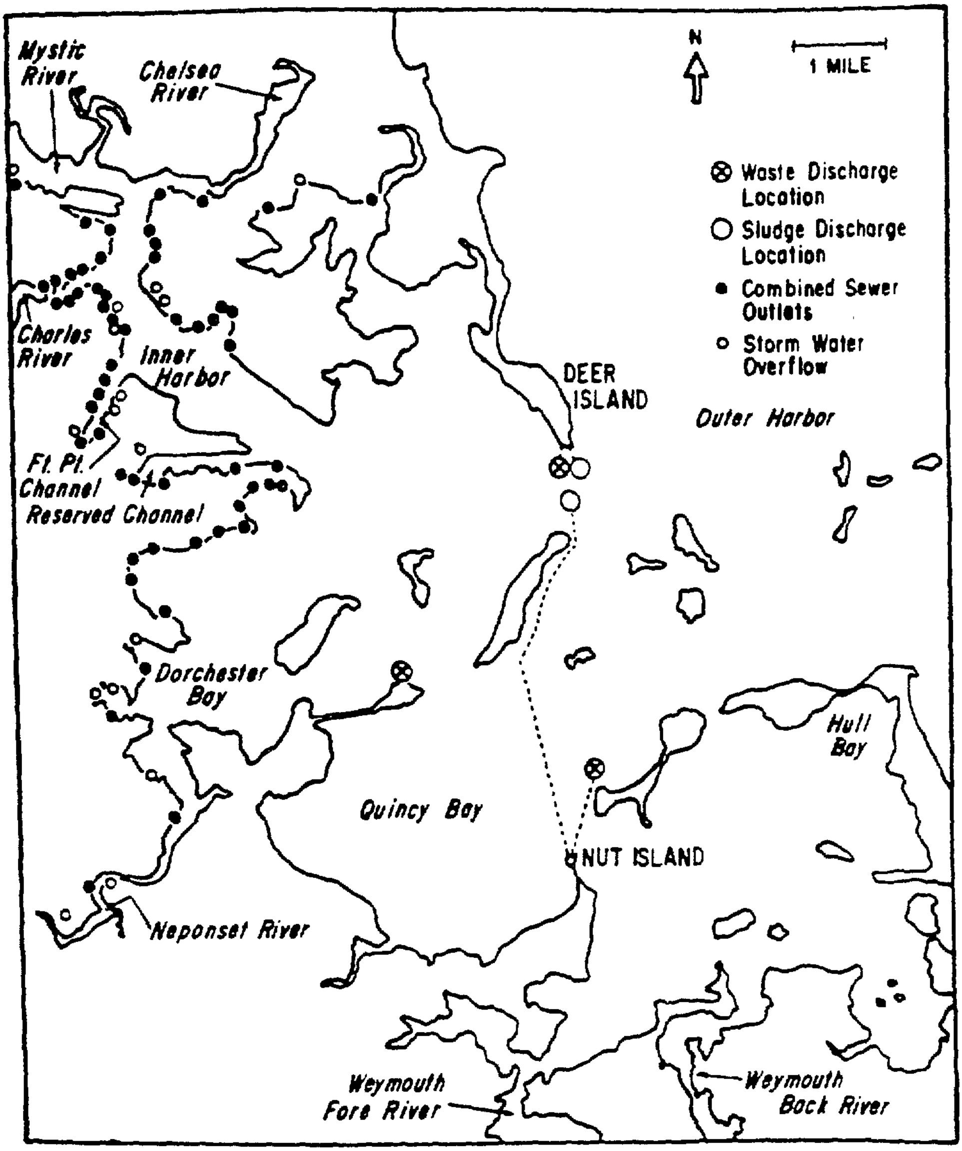

Figure 1. Location of discharges to Boston Harbor.

Boston Area Wastewater Management: the Public's Changing Role

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Introduction

The Massachusetts Water Resources Authority (MWRA) superseded Metropolitan District Commission (MDC) responsibility for Boston area sewerage operations at the beginning of July, 1985 (MWRA, 1985). One of the many aspects of Harbor management which merits study during these first years of MWRA jurisdiction is the changing role of public participation in ensuring clean water. The MWRA, unlike its predecessor, requires public input as part of the decision-making process in many instances (MWRA, 1987). What is the structure for public participation in MWRA decision- making? How effective has the public been in influencing water quality management decisions under the Authority? In his article "Varieties of Citizen Participation (Petersen, 1984)," Sheldon Krimsky concludes that three key considerations determine how meaningful public participation in a technological/scientific policy area will be. Whether public participation in MWRA planning meets Krimsky's guidelines regarding the timing of public input, the form of public input, and the sector of the public involved, may serve as a viable method of judging the effectiveness of public contributions to Boston Harbor water quality management. Special reference is made to public participation in the Harbor siting of a planned effluent outfall pipe.

Krimsky on Effective Public Participation

According to Krimsky, the initial stages are particularly crucial to any policy-making or planning effort. When proposals or regulations are put together and then opened to public comment, public ability to alter the content of the circulated material is generally minimal. Therefore, public participation in a given project should begin early if it is to carry full weight in the planning process. The public should have an "active" rather than a "reactive" part in decision-making (Petersen, 1984).

The public's achievement of an active role in decision-making is, in Krimsky's view, tied to the choice of the right framework for public input. While many forms of public participation are possible—the hearing, task force, advisory panel, and citizens' review board are a sampling of some of the vehicles more frequently encountered—Krimsky's emphasis is on using whichever system will, in a given case, facilitate the timely flow of ideas and information between citizens and technocrats. Such exchange is expected to increase community acceptance of decisions reached and action envisioned, particularly where technical/ scientific considerations are of importance (Petersen, 1984).

As to which sector of the public should participate, Krimsky singles out population groups at risk from the contemplated decision(s). He defines "at risk" as meaning threatened by "adverse effects on health and well-being (Petersen, 1984)." Krimsky favors special attention to the opinion of the population put at risk even when they are greatly outnumbered by those who will benefit. Expanding the same principle, communities which must absorb negative consequences of government decisions which benefit a larger population should have access to channels for pressing their concerns. Krimsky cautions, however, for a group to have a representative at a hearing or on the right committee is not enough, especially where technological issues are concerned. The representative, to be effective, must have certain qualities. These include the ability to grasp new concepts quickly, to follow jargon-laden discussions, and to deal with "experts" comfortably, without being intimidated. How well a group is represented, in other words, may depend on the selection of an articulate, competent spokesperson with a natural facility for understanding technical matters (Petersen, 1984).

Using Krimsky's criteria as a measure, to what extent can public participation in MWRA decision-making be designated as effective? First an outline of the public participation infrastructure of MWRA is offered. Attention next turns to an example of public participation contributing to water quality management: the role of the public in establishing criteria for outfall pipe siting is briefly sketched. The evaluation of effective public participation which then follows will also serve to integrate the various sections of the discussion and to lead into the concluding remarks of the paper.

MWRA Public Participation Infrastructure

A number of mechanisms are key to public input in MWRA decision- making. The central arm of citizen participation in MWRA, the Citizens' Advisory Committee (CAC), has met monthly since October, 1986. The formation of the CAC was first announced in July, 1986 in a Massachusetts Executive Office of Environmental Affairs (EOEA) publication, the *Environmental Monitor*. Mailings regarding the Committee went directly to an additional several hundred individuals and groups. A notice was placed in the MWRA publication *On the Waterfront*, which has a circulation of 1,500. Suggestions were also solicited from members of an informal CAC which had been working on another piece of the MWRA wastewater project, the Residuals Management Facilities Plan (RMFP). The initial October meeting took place the same month that the forty- three members, 28 representatives and 15 alternates, were appointed to the formal committee by EOEA Secretary James Hoyte (MWRA, 1987).

Many committee members are active in other community roles in addition to their involvement with MWRA. The range of their affiliations spans other environmentally-related organizations, community organizations of a non-environmental nature, marine and waterfront commercial ventures, other businesses, industry and other government offices (MWRA, 1987). The selection process thus seems to have gathered a diverse group of representatives, active in public and community affairs, generally with strong personal interest in being part of CAC deliberations.

CAC has spawned subcommittees to provide closer examination of particularly complex or troublesome issues. Outfall site evaluation, for example, is one of the issues which has prompted the formation of a subcommittee. Subcommittees meet as needed, usually at the end of each month. Still smaller sub-groups generally meet as needed at the beginning of the month. In the CAC, the Outfall Subcommittee, and the Outfall Subcommittee sub- groups, reading material relevant to the next month's discussion is distributed at the preceding meeting as much as possible; otherwise it is distributed by mail. Agendas and minutes are also sent out prior to monthly meetings (MWRA, 1987).

Subsequent to the establishment of the CAC, a Technical Advisory Group (TAG) was organized in conjunction with the MEPA unit of EOEA to provide guidance on technical matters. TAG serves the additional purpose of bringing together input from the many agencies whose regulatory, permitting, funding or other authority impinges on planning for the Harbor. Twenty-two names are included in the TAG membership listing. Those on the list represent more than fifteen different agencies at the municipal, state, and federal levels. When CAC members are handed planning or other technical documents, they also receive comments on the materials from TAG personnel. Before planning or other technical documents are examined by CAC members, TAG personnel are asked to comment on the materials (MWRA, 1987).

Providing information through newspapers, libraries, and other resources and arranging for public meetings are additional routes MWRA has taken to keep the public abreast of, and to gauge its response to, agency efforts. Public meetings fall into three general categories, forums, public information meetings, and meetings with affected communities. All of these meetings enable citizens to express their concerns and to engage in dialogue with MWRA officials. The agency, however, retains the final authority to accept or reject public demands (MWRA, 1987).

Outfall Site Evaluation

At the beginning of November, MWRA announced that careful evaluation of seven possible terminus locations for the proposed effluent outfall pipe recommended the selection of one of the two sites farthest-most from Deer Island (Rizzo, 1987). How was this decision reached and how, if at all, did public participation influence MWRA's choices? An examination of the role of such groups as the CAC Effluent Outfall Subcommittee in outfall siting evaluation promises some answers to these questions while providing insight into the function of public participation within the MWRA framework. Focusing on the establishment of criteria for outfall evaluation proves particularly instructive.

Outfall Site Evaluation is a segment of the Secondary Treatment Facilities Plan (STFP) now being developed by MWRA. As part of the plan, a new wastewater treatment facility is scheduled for construction on Deer Island in Boston Harbor. One by-product of wastewater operations at the plant will be treated effluent which will require subsequent disposal. Standard practice dictates disposal of such effluent back to the marine environment via massive conduits. The location of the end of the effluent outfall pipe may have telling effect on the impact of the pipe discharge on the surrounding marine ecosystem. The job of outfall site evaluation is to locate the terminus of the outfall pipe so that harmful impacts of effluent discharge are minimized (MWRA, 1987).

The CAC Outfall Subcommittee, responding to the issue of where to discharge the outfall pipe effluent, produced a series of concerns which fit into two categories, impact concerns and engineering concerns. Seven concerns were listed under the impact category and nine under engineering (MWRA, 1987). MWRA staff were asked to integrate the CAC concerns with other standards being used to evaluate proposed outfall sites. The CAC request led MWRA to cross-tabulate Outfall Subcommittee concerns with other site selection criteria (MWRA, 1987). Comments on criteria were solicited at the end of the summer from the Secretary of Environmental Affairs and through their publication in the Environmental Monitor (MWRA, 1987). With a finalized set of criteria covering public concerns and regulatory requirements, each of seven pre-identified sites was evaluated on a point-by- point basis (MWRA, 1987). By November 4, 1987, MWRA was ready to recommend the location of effluent discharge between 7.5 and 9.5 miles east-northeast of Deer Island (Rizzo, 1987).

While MWRA's choice of an outfall discharge region seems to incorporate CAC concerns, it overlooks the more fundamental issue, raised by the Outfall Subcommittee and TAG at this juncture, as to whether a siting decision is premature without further oceanographic analysis (Deer Island Facilities Planning, 1987). The same reservation about outfall siting without sufficient study surfaced several times when MWRA circulated a preliminary draft of the outfall criteria, "Proposed Outfall Evaluation Criteria," in the summer of 1987. Dr. Thomas Hruby, for example, responding for the Massachusetts Audubon Society, writes:

> The question of the adequacy...of the data to be used has been brought up by several members of the EOEA Technical Advisory Group on Boston Harbor. I do not believe this question has been properly addressed in the program design. Given the highly seasonal nature of conditions in the harbor, an explanation is needed why the proponents believe data collected only during the summer will provide enough information on actual maximum/minimum conditions that can be expected at the proposed sites (Hruby, 1987).

Dr. Kenneth Sebens, Director of the Marine Science Center, Northeastern University, is another critic. According to Sebens:

> A decision will probably be made based on only a few months data at the specific sites in question. This is insufficient for physical oceanographic modelling or for even a basic description of the biological community at the proposed sites. The evaluation criteria should include plans for continued study for at least a year....(Sebens, 1987).

The doubts that Drs. Ruby and Sebens voice about the quality of data available for effluent outfall siting lends credence to the Outfall Subcommittee's call for further research.

The community closest to the proposed outfall sites, Nahant, speculates on the effect of financial and scheduling pressures on MWRA thinking in comments dated July 10, 1987 and in a later letter. The July 10 document first quotes the declaration of the "Proposed Criteria" that decision-making will reflect diverse points of view. It then argues that, because the decision-makers are not identified, there is no satisfactory indication of the diversity of their opinions. The document goes on to argue that if, for example, the decision-makers were the MWRA board of directors, their outstanding interest might be to keep down project costs rather than to protect the Nahant shoreline (SWIM, 1987). The second piece of correspondence from Nahant, sent in September to Environmental Affairs Secretary Hoyte, reiterates the worry of some residents that "...the criteria 'Timely Implementation' may turn out to be...the only criteria actually used to determine outfall length (SWIM, 1987)."

Thus, on the one hand, MWRA successfully incorporated citizens' concerns in ranking potential outfall sites. The agency seems less inclined to act on public urging to postpone outfall site selection in the interests of further data collection. Some possibility exists that in this regard MWRA officials are constrained in their response by time and money considerations.

Effectiveness of Public Water Quality Management Role

Public participation in MWRA outfall siting evaluation seems to follow Krimsky's model. The fact that, as a general rule, 1) CAC and Outfall Subcommittee members get materials for the next month's meeting several weeks in advance; and, that 2) CAC concerns were solicited early enough to include them in criteria for outfall siting, fulfills Krimsky's definition of proper timing. Public participation, as a result, is "active," not "reactive." CAC/ TAG efforts to extend study of environmental conditions give evidence of this "active" public role. As for what, according to Krimsky, constitutes a proper vehicle, several formats in the MWRA siting example, the Citizens' Advisory Committee and Subcommittee among them, fit the model in question. TAG provides technical support as required.

Who should participate is a final consideration in evaluating the effectiveness of public participation. While CAC does not have a representative from every at-risk community, it does have a representative from each potentially affected region. These individuals, as well as other members of CAC and its subcommittees seem to be articulate and able to follow technical arguments. Judging by their outside (i.e., non CAC) affiliations, the advisory committee representatives are a diverse group who bring a range of perspectives to Harbor issues. Once again the role of the public within MWRA corresponds to Krimsky's concept of what makes public participation in science and technology issues effective. On the basis of Krimsky's three-part model, therefore, public participation in MWRA is effective in influencing Boston water quality management.

Conclusion

In review, there have been marked changes in the public role in Boston water quality management since the transfer of sewerage operations from the MDC to MWRA. Public participation in water quality management issues has expanded considerably. The public has more direct, timely input into Boston Harbor water resource issues. Moreover, that input appears to be effective, at least in respect to the criteria established by Krimsky.

Krimsky's guidelines, however, do not address whether public participation within an institution is as effective as it can be from outside. Referring to the outfall siting case by way of illustration, MWRA on the one hand incorporated concerns of the CAC in writing its criteria for outfall site evaluation; on the other hand, the agency was less inclined to act on calls by the full CAC, its Outfall Subcommittee, TAG and other interested members of the public to delay a siting decision in favor of further data collection. Worry about cost and time overruns may be the cause of this disinclination to respond on the part of MWRA administrators. The question which lingers in this regard is how hard the CAC, an MWRA animal, will press for the delay it is recommending. The present discussion has focused on public participation efforts within MWRA, i.e., "in-house" efforts. A possibly valuable line of future inquiry is to study the comparative abilities of in-house public participation efforts and an outside citizen action group to influence the choices of a given government agency.

Bibliography

Doneski, David. "Cleaning Up Boston Harbor: Fact or Fiction?" *Boston College Environmental Affairs Law Review* 12 (1985): 559-625.

Dumanoski, Diane. "Who Speaks for the Harbor?" *Boston Globe Magazine.* 20 August 1987: 16-17, 82-93.

Haar, Charles M., ed. *Of Judges, Politics and Flounders: Perspectives on the Cleaning Up of Boston Harbor.* Lincoln Institute of Land Policy, Land Policy Roundtable, Case Studies Series, No. 305. Cambridge, Massachusetts: Lincoln Institute of Land Policy, 1986.

Hruby, T. "Comments on Draft Outfall Evaluation Criteria." 22 September 1987. Library, MWRA. Charlestown, Massachusetts.

Kildow, Judith T. *Boston Harbor Management Study. A Final Report.* MITSG 81-15. Cambridge, Massachusetts: MIT Sea Grant, November, 1981.

Langton, Stuart, ed. *Citizen Participation in America.* Lexington, Massachusetts: D.C. Heath and Company, 1978.

Massachusetts Water Resources Authority. *Secondary Treatment Facilities Plan.* Vol. V. Effluent Outfall. Charlestown, Massachusetts: MWRA, November 13, 1987.

Massachusetts Water Resources Authority. *The Clean-Up of Boston Harbor: A Status Report.* Charlestown, Massachusetts: MWRA, May 30, 1985.

Metropolitan Area Planning Council. *Boston Harbor Islands Comprehensive Plan.* Prepared for Massachusetts Department of Natural Resources. Boston, Massachusetts: Metropolitan Area Planning Council, October 1972.

Petersen, James C., ed. *Citizen Participation in Science Policy.* Amherst, Massachusetts: University of Massachusetts Press, 1984.

Rizzo, Denise Ellen. "'Most Distant' Sewage Outfall Site Backed," *Winthrop Sun-Telegraph.* 4 November 1987: 1,16.

Sebens, Dr. Kenneth P. "Comments on Outfall Siting Criteria." August 1987. Library, MWRA. Charlestown, Massachusetts.

SWIM: Nahant Citizens Committee, "Nahant Comments on 'Proposed Outfall Evaluation Criteria.'" 10 July 1987. Library, MWRA. Charlestown, Massachusetts.

SWIM: Nahant Citizens Committee. Letter to Secretary of Environmental Affairs James S. Hoyte. 22 September 1987. Library, MWRA. Charlestown, Massachusetts.

NORTH FRASER HARBOUR ENVIRONMENTAL MANAGEMENT PLAN

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Introduction

In September, 1988 the North Fraser Harbour Commission (NFHC), the federal agency responsible for administering the Port of North Fraser, and the federal Department of Fisheries and Oceans (DFO), responsible for managing and conserving national fisheries resources, signed the North Fraser Harbour Environmental Management Plan. The Plan is being viewed by port administrators, habitat managers and environmental public interest groups as an innovative and positive cooperative management initiative.

The Port of North Fraser, located in the Fraser River estuary in southwestern British Columbia, Canada, is a shallow draft harbour which handles over 14 million metric tonnes of cargo annually. The harbour is situated in one of the most environmentally sensitive estuaries on the Pacific coast of North America and is surrounded by the Vancouver metropolitan area which supports a population of over one million people and includes intensive industrial operations. To deal with environmental concerns associated with port development and operation, the NFHC, in cooperation with DFO, has developed a pro-active and comprehensive planning approach to ensure that environmental considerations become an integral component of port management.

Management of the Fraser estuary involves numerous agencies and it is critical that a cooperative approach be used during implementation of the Plan. Since the signing in September, a work plan has been developed by NFHC and DFO staff, and discussions have been initiated with several other agencies to begin implementation of selected action options. This paper briefly describes the main components of the Plan and outlines the activities that will be undertaken during the first year.

Components of the Plan

Development of the Plan was initiated by the NFHC in April 1985. Several preliminary reports were prepared by a consultant for the NFHC (Williams 1985; 1986a; 1986b) prior to finalization and signing of the Plan in September 1988 (Anon 1988). The Plan consists of four main components:

1. shoreline habitat classification map showing productivity rating and associated level of mitigation/compensation;

2. specific site assessment procedures for developers in the North Fraser Harbour;
3. introduction of the first habitat compensation bank in Canada to provide more systematic and effective compensation for water dependent projects;
4. cooperative management program aimed at enhancing interagency cooperation and communication, habitat cleanup, improving water quality, and applied research.

Shoreline habitat classification

Although a habitat data base existed for the North Fraser Harbour, much of the data was of limited use for port planning. Therefore the NFHC and DFO agreed that a joint habitat inventory should be conducted. All existing habitat information for the North Fraser Harbour was compiled and field surveys were undertaken in July 1986 to quantify marsh and riparian habitats in the harbour (Williams 1986c). The information was used by DFO to rate shoreline habitats and a shoreline classification was developed (Figure 1).

Under the classification, shoreline habitats were classified as having high (i.e. red), moderate (i.e. yellow) or low (i.e. green) productivity values for juvenile salmon. The colour coded classification was selected to identify shoreline sensitivity to development and level of mitigation or compensation required. For example, highly productive habitats can not be developed unless the productive capacity of the site can be maintained. The colour coding also provides an indication of the level of mitigation or compensation required: highly productive habitats complete mitigation and compensation, if permitted, while development can proceed in low value areas with only normal mitigation requirements.

The shoreline habitat classification provides port planners and potential developers with a very useful and pro-active management tool, which has the consensus of the NFHC and DFO. It also serves as the foundation of the Plan, because from this consensus it was possible to develop some very specific and precedent setting initiatives.

Project Review and Assessment Procedures

The second component of the Plan consists of preparing site assessment procedures for water dependent development. Under the Fraser River Estuary Management Program (FREMP), a joint federal- provincial program designed to promote better coordination of management activities in the estuary, a coordinated project review has been established which has improved the efficiency of project review (Lambertsen 1987). To improve the procedure further, the NFHC will develop guidelines for site assessment to improve project documentation and reduce the time required for project referrals and approvals. It is anticipated that locating development proposals in areas having lower productivity (e.g. using the North Fraser Harbour shoreline habitat classification) and preparing proper and complete project proposals will encourage developers "to do it right".

Habitat compensation banking

The most precedent setting component of the Plan is the establishment of a habitat compensation bank. The NFHC habitat bank is the first to be approved in

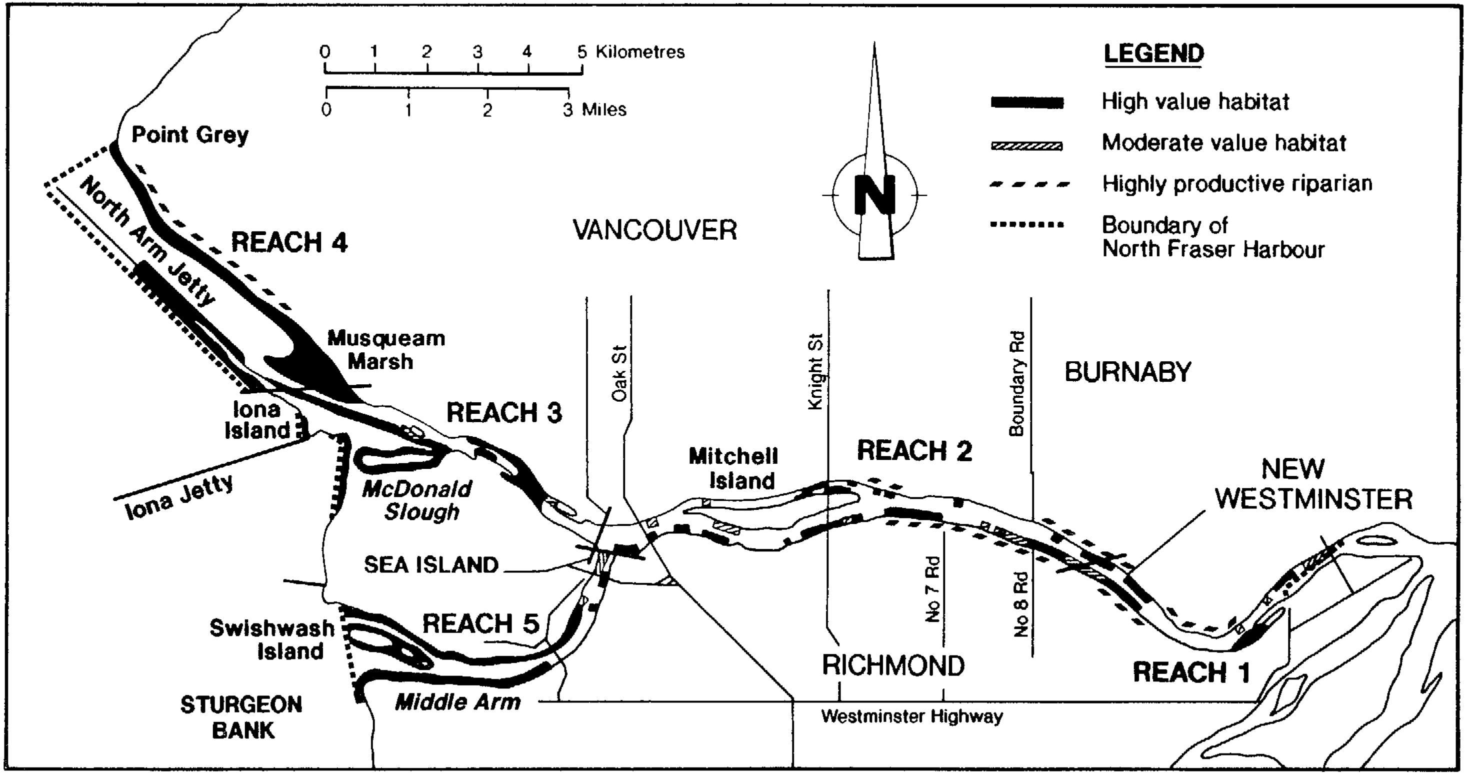

Figure 1 North Fraser Harbour Shoreline Habitat Classification
(Note: Low value shoreline habitat has not been shaded)

Canada, and has required intensive negotiation and modification with DFO before it was considered complementary to the national fish habitat policy (DFO 1986). Under the bank, the NFHC will develop habitat (e.g. create marsh, riparian or mudflat) for the sole purpose of providing compensation for habitat destroyed during construction of wate

The NFHC habitat bank has several restrictions. The North Fraser Harbour has been divided into five reaches and habitat created for banking purposes can only be used for developments within the same reach. Habitats within the bank can only be used for development within moderately productive areas (i.e. yellow). It is anticipated that as the technology for habitat creation improves and the results indicate that full replacement of natural habitats can occur, banking may apply to highly productive areas as well.

The NFHC will be responsible for administering the bank and keeping a habitat audit. All habitats must also be show to be successful prior to being used as habitat credits by developers for compensation. Presently, DFO uses standard compensation ratios of 2 (habitat compensation area):1 (habitat destroyed due to development) for marshes and 1:1 for mudflat and riparian. Compensation areas must be in close proximity to the development site, and like-for-like habitat compensation is preferred (e.g. marsh-for-marsh).

Cooperative Management Program

The fourth component of the Plan is the Cooperative Management Program which includes a number of initiatives that will involve the cooperation of other agencies. Initiatives under the program will include:

1. habitat creation (not to be included in the habitat compensation bank);
2. harbour keeping (shoreline cleanup);
3. improving water quality;
4. enhancing inter-agency communications;
5. conducting joint applied research;

First Year Activities Under the Plan

One of the main objectives of the NFHC is to implement pro-active and action orientated initiatives under the Plan to improve the environmental quality of the harbour and increase the efficiency of harbour management. The NFHC-DFO steering committee has prepared a work plan that will involve implementing several initiatives covering a broad range of activities. Since the Plan only became operational in September, implementation has only just begun.

1. Shoreline habitat classification maps

The North Fraser Harbour shoreline habitat classification has been finalized and sets of 1:2500 aerial photograph mosaic maps are being colour coded for use by harbour administrators and habitat managers. The photographic mosaics provide excellent resolution and were used during the shoreline habitat surveys to record field data. The NFHC is installing a computerized GIS mapping system which should be fully operational within a year. Once the GIS system becomes operational the shoreline classification will also be entered into the system.

2. Shoreline cleanup

A list of potential cleanup areas has been prepared based on field observations made during the shoreline habitat inventory and follow-up reconnaissance. Emphasis is being placed on areas which would benefit from general cleanup (e.g. debris or log debris removal) and subsequent installation of habitat protection facilities (e.g. shear booms to deflect floating debris).

3. Habitat Compensation Bank

Several potential habitat compensation sites and techniques have been identified for consideration by the NFHC. Early selection of banking sites will permit the NFHC to act in a pro-active manner in establishing banking credits. For example, the NFHC must conduct routine channel dredging to maintain sufficient draft for vessel navigation, and dredge spoil could be used to create marsh habitat. In this way disposal of dredge material could be used to enhance the productive capacity of the harbour.

4. Harbour Environmental Patrol

A harbour patrol constantly monitors activities in the harbour. However, the purpose of the patrol is usually confined to navigation and log transport related activities. The NFHC has approved establishment of an environmental surveillance of the harbour to identify and report activities that are detrimental to environmental quality (e.g. illegal filling, unpermitted discharges, oil and chemical spills, fish kills). A proposed "unpermitted discharge log" and surveillance guidelines have been drafted (Williams 1988), and discussions concerning implementation are underway with the appropriate federal and provincial agencies responsible for managing pollution abatement and control.

5. Hazardous Waste Audit

To improve harbour planning, the NFHC will complete an inventory of hazardous chemicals in the North Fraser Harbour. Much of the information has been collected by the provincial Waste Management Branch and will be used to prepare the inventory. The data collected will eventually be entered into the GIS system and made readily available for port planning, surveillance and response.

6. Harbour Keeping Brochure

The NFHC is aware that the Plan will only succeed with the cooperation of all harbour users, including industry, the public and special interest groups. Therefore, during the first year a professional brochure will be developed to inform harbour users of the objectives and components of the Plan and solicit their participation. Being the main development agency for the Port of North Fraser, it is the intention of the NFHC to work with harbour users to improve environmental quality in the harbour.

7. Harbour Keeping Workshop

As a follow-up to the harbour keeping brochure, the NFHC will hold a workshop and invite representatives from all sectors of harbour users. The workshop will outline the objectives and undertakings of the Plan, and solicit active participation. It will also provide a forum for industry and the public to inform the NFHC of critical areas for improvement and/or measures already being implemented to improve the environmental quality of the North Fraser Harbour.

8. Development Project Guidelines

The NFHC is convinced that pro-active measures are the best ways to ensure sustained environmental quality. As the lead development agency for the North Fraser Harbour, it can play an important role in encouraging developers to prepare environmentally sound project designs, mitigation and operational strategies. To help to bring this about, the NFHC will prepare written guidelines on habitat assessment procedures and documentation, and "generic" mitigation and compensation techniques, so that mitigation measures can become a much more integral part of project design.

9. Applied Research

Although research can be very expensive, several activities have been proposed for consideration that would provide site specific data for making better management decisions. One idea being considered is to develop physical guidelines for determining site potential for habitat creation. For example, it may be possible to determine hydraulic threshold levels for habitat creation and/or wave protection measures.

Acknowledgements

The authors gratefully acknowledge the logistical and technical assistance of Mr. Otto Langer and Mr. Kevin Conlin, DFO. Mr. Ken Bierly of the Oregon Division of State Lands kindly supplied information on Oregon examples of mitigation banking.

Literature Cited

Anon. 1988. Memorandum of understanding concerning an environmental management plan for the North Fraser Harbour between the Department of Fisheries and Oceans (DFO) and the North Fraser Harbour Commission (NFHC). North Fraser Harbour Commission, Richmond, B.C.: 27 p.

DFO. 1986. The Department of Fisheries and Oceans policy for the management of fish habitat. Dep. Fish. Oceans, Ottawa: 30 p.

Lambertsen, G.K. 1987. A guide to the coordinated project review process. Fraser River Estuary Management Program. New Westminster, B.C.: 35 p.

Williams, G.L. 1985. Proposed North Fraser Harbour environmental management agreement. Unpubl. Hatfield Consultants Ltd. Rep. to North Fraser Harbour Commission, Richmond, B.C.: 13 p.

Williams, G.L. 1986a. North Fraser Harbour: proposed environmental management agreement guidelines. Unpubl. Hatfield Consultants Ltd. Rep. to North Fraser Harbour Commission, B.C.: 27 p.

Williams, G.L. 1986b. North Fraser Harbour Environmental Management Plan (preliminary guidelines). Unpubl. G.L. Williams & Assoc. Rep. to North Fraser Harbour Commission, Richmond, B.C.: 41 p.

Williams, G.L. 1986c. North Fraser Harbour shoreline habitat inventory. Unpubl. G.L. Williams & Assoc. Rep. to North Fraser Harbour Commisson, Richmond, B.C.: 35 p.

Williams, G.L. 1987. North Fraser Harbour Environmental Management Plan water quality action options. G.L. Williams & Associates Ltd. Unpubl. Rep. to North Fraser Harbour Commission, Richmond, B.C.: 5 p.

PROGRESS IN REMEDIAL ACTION PLANNING TO MODERATE POLLUTION OF LAKE ONTARIO

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I. INTRODUCTION

Beginning in 1973, and continuing for a decade thereafter, the International Joint Commission's Water Quality Board had reported on progress, or lack thereof in cleaning up the most heavily polluted waters in the Great Lakes. Dubbed the "Areas of Concern", these are harbors and mouths of streams and rivers which have played important roles in generating the wealth of the U.S. and Canadian Midwest. The side effects of this development have taken their toll. The Areas are polluted by the phenols released by paper mills, dioxin from chemical companies, polyaromatic hydrocarbon (PAH) by-products of fossil fuel combustion, phosphorus from inadequate sewage treatment and much more. Almost all of the Areas contain heavily polluted bottom sediments, a problem for which no clear solutions exist.

The Water Quality Board recorded and maintained a list of these waters: first known as the "Problem Areas" and subsequently renamed, "Areas of Concern." Ostensibly, the list represented a consensus as to where the greatest problems existed, and it established meaningful priorities for clean-up efforts. The ultimate goal was to remove an area from the list. However year after year the Board, in its annual report, repeated the list, changing criteria here, consolidating areas there, but almost never reporting that successful remediation of the fundamental problems had led to the removal of an Area from the list.

Not that progress didn't occur. In fact both nations responded to domestic political pressure and the international obligations they had incurred as a result of the U.S.-Canada Water Quality Agreement by spending billions of dollars in the 1970s to upgrade sewage treatment plants. These efforts, combined with widespread bans on phosphates in detergents, brought significant reductions in the excess phosphorus which had been feeding the oxygen- depleting algal blooms that choked off other forms of life in the lakes. Environment Canada reporting on Lake Ontario in 1984 reported that, "Lake Ontario has been observed by analytical chemistry methods since 1966 --- The lake's recent recovery from eutrophication is a major success story in environmental control." (Dobson, 1984, p. xiii) However after successfully slowing the cultural eutrophication trends, new, more insidious problems became apparent.

As fish began to return to waters they had previously abandoned, many of them developed cancerous tumors and other abnormalities, particularly those residing in Ohio Cuyahoga River and the Buffalo River in New York. Cormorants and other wildlife displayed rare genetic malformations thought to result from PCB contamination. In all but two of the designated Areas, contamination from heavy metals and organic chemicals posed and continue to pose major problems. Complicating the problems of toxic pollution is the fact that the sources of contamination are not necessarily active discharges, but rather come from leaking hazardous waste dumps, contaminated groundwater, resuspension from bottom sediments and the constant deposition of airborne contaminants.

Thus despite the progress made in tackling "conventional" pollution, the most industrialized and populated nearshore areas continued to be listed year after year as waters failing to meet the goals established in the Great Lakes Water Quality Agreements of 1972 and 1978. Clearly if the goals of the Agreements were ever to be reached, new serious clean-up efforts would have to be initiated. By 1984, the Commissioners of the International Joint Commission were asking their own Water Quality Board to change direction and push the states and provinces harder to produce plans and timetables for cleaning up the problem areas. Prior to this, all the Water Quality Board's efforts had been focused on documentation rather than action. As a result of the Commissioner's critique of progress in the Areas the IJC Water Quality Board developed a new system for categorizing these problem areas. The new system categorized the Areas according to criteria based on measures of progress the jurisdictions had, or had not, made in developing and carrying out plans for recovering the Areas. These clean-up plans were Remedial Action Plans (RAPs).

In 1985 the Water Quality Board initiated the Remedial Action Plan program. The Board, consisting of water pollution control bureaucrats from both federal governments and each Great Lake state and the Province of Ontario, is responsible under the U.S.- Canada Great Lakes Water Quality Agreements for monitoring progress, or lack thereof, in accomplishing the goals of the Agreements. The Areas of Concern designation, and the Remedial Action Planning process is the most recent phase in a two-decade long effort to focus attention on the Great Lakes' most seriously polluted waters.

The Remedial Action Plan (RAP) program marks a clean departure from traditional IJC activities in the following significant ways:

1. The RAP program marks a reversal in the historical flow of policy direction. In the past, the IJC had made recommendations only when the governments asked it asked for specific information. The type of recommendations and the range of information expected by the government was clearly delineated in the reference, or request, issued jointly by the two national governments. In the case of the Remedial Action Plan program, the IJC Water Quality Board is issuing explicit directions to the jurisdictions that require the jurisdictions to provide specific information and perform certain actions determined by the Board to be necessary.

2. As a result of the RAP program the IJC, which has historically dealt almost exclusively with the federal governments, is becoming increasingly involved through the Water Quality Board with state and local jurisdictions who are charged with creating the RAPs.

3. By insisting that public participation is critical to the success of Remedial Action Plans, the IJC is becoming involved with environmental activist and activism, and the relationships between jurisdictions and their citizens in a previously unheard of manner.

There is no question that the RAP program constitutes a direct challenge to the status quo relationships between the IJC and the federal, state and local jurisdictions. It is equally clear that something more than the status quo is required to clean up the Great Lakes Areas of Concern. Whether this new direction will result in cleaning up the Areas of Concern or instead polluting the bilateral political environment is yet to be determined.

This paper focuses on what progress has been made in Remedial Action Plan formulation for Areas of Concern for the Great Lakes. We will further restrict our focus primarily to Lake Ontario and the planning activity ongoing in New York State and the Province of Ontario. The remainder of the paper will cover; evaluation of Areas of Concern, the 1988 Report on Great Lakes Water Quality; current environmental patterns in the Lake Ontario Areas of Concern; the Lake Ontario RAPS, the RAP document and process, and finally key participation process issues that are evolving for the RAP process.

II. Evolution of Areas of Concern

As part of its advisory role the Water Quality Board began early on identifying those geographical locations where either specific objectives of the 1972 Water Quality Agreement were not being met, or where jurisdictional standards were exceeded. Originally 63 areas were identified. Over time some of these areas were consolidated while some were identified with "whole lake" problems an so the number was reduced to 42. (See Figure 1 and Table 1).

TABLE 1

AREAS OF CONCERN IN THE GREAT LAKES BASIN

MAP REF. NO.	[a] LAKE BASIN/AREAS OF CONCERN	JURISDICTION
	LAKE SUPERIOR:	
1	Peninsula Harbour	Ontario
2	Jackfish Bay	Ontario
3	Nipigon Bay	Ontario
4	Thunder Bay	Ontario
5	St. Louis River	Minnesota
6	Torch Lake	Michigan
7	Deer Lake-Carp Creek-Carp River	Michigan
	LAKE MICHIGAN:	
8	Manistique River	Michigan
9	Menominee River	Michigan/Wisconsin
10	Fox River/Southern Green Bay	Wisconsin
11	Sheboygan	Wisconsin
12	Milwaukee Estuary	Wisconsin
13	Waukegan Harbor	Illinois
14	Grand Calumet River/Indiana Canal	Indiana
15	Kalamazoo River	Michigan
16	Muskegon Lake	Michigan
17	White Lake	Michigan
	LAKE HURON:	
18	Saginaw River/Saginaw Bay	Michigan
19	Collingwood Harbour	Ontario
20	Penetang Bay to Sturgeon Bay	Ontario
21	Spanish River Mouth	Ontario

	LAKE ERIE:	
22	Clinton River	Michigan
23	Rouge River	Michigan
24	Raisin River	Michigan
25	Maumee River	Ohio
26	Black River	Ohio
27	Cuyahoga River	Ohio
28	Ashtabula River	Ohio
29	Wheatley Harbour	Ontario
	LAKE ONTARIO:	
30	Buffalo River	New York
31	Eighteen Mile Creek	New York
32	Rochester Embayment	New York
33	Oswego River	New York
34	Bay of Quinte	Ontario
35	Port Hope	Ontario
36	Toronto Waterfront	Ontario
37	Hamilton Harbour	Ontario
	CONNECTING CHANNELS:	
38	St. Mary's River	Ontario/Michigan
39	St. Clair River	Ontario/Michigan
40	Detroit River	Ontario/Michigan
41	Niagara River	Ontario/New York
42	St. Lawrence River	Ontario/New York

[a]See Figure 1.

In 1978 the Great Lakes Water Quality Agreement of 1978 was concluded and new attention and concern was paid to the problems of toxic pollutants. As a result, the Water Quality Board reviewed the Problem Areas in light of the new Agreement. In 1981 the Board determined that notable problems existed in its criteria for establishing the characterizing Problem Areas and monitoring clean-up progress. The criteria, the Board concluded, lacked consistency across the Areas in identification of problems and causes. Further, the 1978 Agreement demanded that an ecosystem approach be taken to Great Lakes problems, yet the criteria used to determine major Problem Areas were written only in terms of water quality data. As a result of this critique of its then current criteria the Board updated and modified its approach and renamed the Problem Areas, Areas of Concern. New classification procedures were adopted that relied on environmental quality data for sediment, biota and water. These new classification procedures created two categories for identifying Areas of Concern.

Category A: significant environmental degradation, beneficial uses severely impaired.

Category B: environmental degradation, beneficial uses may be impaired.

Criteria were established for determining an Areas category based on which Agreement objectives were exceeded; the concentration, persistence and toxicity of the contaminants found; and the geographic extent of problem. As a result the Areas were divided into nearly equal numbers of A & B Areas.

One problem with the new classification procedure that became immediately evident was the tendency to consider those Areas now classified as a B Area of Concern as being less of a problem than they were before the classification procedure was adopted. According to the 1985 Report on Great Lakes Water Quality, the Board was "sensitive to the concern that these classifications might be construed as tacit approval to abandon remedial actions in one area vis-a-vis another... The Board unequivocally states that all identified areas of concern should be matters of jurisdictional attention. However, because of the highly toxic and, therefore, human-health related problems associated with some areas, and because of limited financial resources, the Board believed that classification was necessary to assist the jurisdictions in their respective environmental management programs." The determination of classification was left to the jurisdictions.

In 1981 the IJC was in an unusual state. Because of death and retirement, only one Canadian Commissioner was actively serving on the IJC. On the American side, the Reagan Administration had fired all three Commissioners and had not yet appointed replacements. The one remaining Commissioner, E. Richard Olsen was a man of philosophical bent apparently taken with some of the cogent critiques of modern life placed on the general philosophical agenda by the environmental movement of the 1970s. He was a stately gentleman, distrustful of technocrats, with loud booming voice who responded to one Water Quality Board report with a resounding lecture that implied the Board was failing in its responsibilities. He was tired of reading documentation the problems. When, he demanded, were the jurisdictions going to get serious about cleaning up these Areas that were seriously failing to meet the goals of the U.S. Canadian Agreements. He insisted that the jurisdictions make plans and set timetables for cleaning up the Areas of Concern.

The full complement of Commissioners was in place in time for the IJC's 1982 report. However, Commissioner Olsen's tone of frustration came through in the Report in the frequently used phrase, "*The Commission again recommends*", reminding the reader that previous reports had urged the same things. The Report noted that,

> "It is of special concern to the Commission that the majority of the areas of concern have been identified in virtually every report of the Water Quality Board since its 1974 Annual Report. The Commission urges the parties to devote special attention and effort to the clean-up and restoration of these polluted areas in the Great Lakes system." (IJC, 1982)

In order to address this concern the Commission proposed a new, expanded role for itself beyond limited role as scientific and technical advisor to the governments. Sharing Olsen's view, the Commission expressed a need to involve itself more directly in the social dynamics out of which the political will to restore the lakes might emerge. The IJC pronounced..."of the view that an evolution in its focus from primarily engineering-scientific concerns, to incorporate matters of social relevance, institutions and human concerns may be of benefit in assessing whether the requirements of the Agreement are being adequately met. The Commission senses that the past information base as provided by its institutions has not been available in a form so that its relevance to larger social concerns and aspirations can be assessed. *A more direct form of discourse between the various institutions which are involved in the regulation of the environmental quality of the Great Lakes system and the many individuals in the basin who would be directly effected by institutional decisions ie: the basin "society at large" is both necessary and desirable.* (emphasis added) The Commission, therefore, feels it should consider a "broadening" of its base of information in order to establish a process for understanding the human context of Great Lakes goals and achievements. Another related aspect is the development of effective process by which the Commission can carry out its public information and public hearing responsibilities under the agreement. (Jockel and Schwartz, 19 ; p. 236)

This suggestion did not receive encouragement from the U.S. State Department which responded with what may one day be seen as the opening volley in a war of words between the IJC and the governments. In its official response to the IJC's First Banal Report the Office of Canadian Affairs in the U.S. State Department told the IJC "rather than a broadening of the Commission's Great Lakes focus as proposed, the State Department believes that the Commission should continue devote its efforts with greater precision" to the technical questions specified in the 1978 Agreement. (Jockel and Schwartz, 19)

It was in this context that the Water Quality Board in its 1985 Report on Great Lakes Water Quality undertook to broaden its scope by overseeing the Remedial Action Plan program.

III. The 1985 Report on Great Lakes Water Quality

The Water Quality Board's 1985 Report on Great Lakes Water Quality broke new ground by establishing a clear sequence of steps toward removing an Area of Concern from the list. Each Area could be categorized according to how near the jurisdictions were to solving the Areas problems. The steps are as follows:

1. Causative factors are unknown and no investigative programs are underway to identify causes.
2. Causative factors are unknown but studies are underway.
3. Causative factors are known, but Remedial Action Plans are not developed and remedial measure are not fully implemented.
4. Causes are known, a RAP is developed, but remedial actions not fully implemented.
5. Causes are known, RAP is developed and all remedial measures undertaken.
6. Confirmation that uses have been restored. (IJC, GLWQB, 1985)

By issuing this report, all the jurisdictions represented on the Board committed themselves to creating RAPs for all the Areas of Concern.

IV. Current Environmental Problems in the Areas of Concern

38 of the 42 Areas have discovered persistent organic toxics and/or heavy metals which exceed guidelines for the protection of aquatic life. Some of the Areas exceed guidelines constantly, others periodically. Jurisdictions have issued fish consumption advisories in 31 of the 42 primarily because of PCB and/or mercury contamination. 27 Areas still have conventional pollutant problems that are hazardous to human health and 5 areas still have occasional high coliform counts periodically closing beaches. Phosphorus enrichment and eutrophication still problem in 8.

V. Specific Environmental Problems in Areas of Concern on Lake Ontario at the Connecting Channels.

The following is an area by area breakdown of major pollutants and other environmental problems of the 7 areas of concern on Lake Ontario and the two connecting channels which are also areas of concern. (See Figure 2 and 3).

BUFFALO RIVER (New York) Map Reference No. 30

NATURE OF PROBLEM:

Types of Problems	Sources of the Problems
Conventional Pollutants	Municipal Point Sources
Heavy Metals	Industrial Point Sources
Toxic Organics	Urban Nonpoint
Contaminated Sediments	Combined Sewer Overflows
Fish Consumption Advisories	In-Place Pollutants
Biota Impacted	Waste Disposal Sites

Water quality degraded due to conventional pollutants and heavy metals. Sediments contaminated with toxic organics and metals, and conventional pollutants.

EIGHTEEN MILE CREEK (New York) Map Reference No. 31

NATURE OF PROBLEM:

Types of Problems	Sources of the Problems
Conventional Pollutants	Industrial Point Sources
Heavy Metals	Urban Nonpoint
Contaminated Sediments	Combined Sewer Overflows
	In-Place Pollutants

Sediments contaminated with heavy metals and conventional pollutants.

ROCHESTER EMBAYMENT (New York) Map Reference No. 32

NATURE OF PROBLEM:

Types of Problems	Sources of the Problems
Conventional Pollutants	Municipal Point Sources
Heavy Metals	Industrial Point Sources
Toxic Organics	Urban Nonpoint
Contaminated Sediments	Combined Sewer Overflows
Fish Consumption Advisories	In-Place Pollutants

In place pollutants (conventional pollutants and heavy metals).
Water quality degradation (conductivity, total dissolved solids).

OSWEGO RIVER (New York) Map Reference No. 33

NATURE OF PROBLEM

Types of Problems	Sources of the Problems
Conventional Pollutants	Municipal Point Sources
Heavy Metals	Industrial Point Sources
Contaminated Sediments	Urban Nonpoint
Fish Consumption Advisories	Combined Sewer Overflows
	In-Place Pollutants
	Waste Disposal Sites

Sediments are contaminated with conventional pollutants and heavy metals. Fish contamination with PCB and mirex above Agreement objectives.

BAY OF QUINTE (Ontario) Map Reference No. 34

NATURE OF PROBLEM:

Types of Problems	Sources of the Problems
Conventional Pollutants	Municipal Point Sources
Eutrophication	Industrial Point Sources
	Urban Nonpoint

Despitereductions in phosphorus loadings, dissolved oxygen, levels remain low in the Adolphus Reach and eutrophication still persists. Zone of intermittently elevated bacterial levels occur as a result of stormwater discharges in the vicinity of Trenton, Belleville, and Picton.

PORT HOPE (Ontario) Map Reference No. 35

NATURE OF PROBLEM:

Types of Problems	Sources of the Problems
Contaminated Sediments	In-Place Pollutants
	Waste Disposal Sites

The sediment in the turning basin of Port Hope Harbour is contaminated with heavy metals, radium, uranium, and PCB. While the water column provides protection against exposure from the in-situ contaminants, dredging and disposal of this sediment has been identified as an environmental concern. Confined to the turning basin, the contamination results primarily from discharges made prior to 1945 as well as occasional contingency spills from Eldorado Nuclear.

TORONTO WATERFRONT (Ontario) Map Reference No. 36

NATURE OF PROBLEM:

Types of Problems	Sources of the Problems
Conventional Pollutants	Municipal Point Sources
Heavy Metals	Industrial Point Sources
Toxic Organics	Urban Nonpoint
Contaminated Sediments	Combined Sewer Overflows
Fish Consumption Advisories	In-Place Pollutants
	Biota Impacted
	Beach Closings

Bacterial contamination, particularly in response to runoff events, occurs at a number of locations along the waterfront. Water supplies are not affected, but some public beach areas are impacted on occasion, restricting their use for swimming. The levels of organic chemicals exceed guidelines and objectives in the sediment of part of Toronto Harbour and Humber Bay and, occasionally in the overlying waters following high precipitation events.

HAMILTON HARBOUR (Ontario) Map Reference No. 37

NATURE OF PROBLEM:

Types of Problems	Sources of the Problems
Conventional Pollutants	Municipal Point Sources
Heavy Metals	Industrial Point Sources
Toxic Organics in Fish	Urban Nonpoint
Contaminated Sediments	Combined Sewer Overflows
Eutrophication	In-Place Pollutants
	Aesthetics

Municipal and industrial discharges, urban drainage, sediments, and algal decay increase oxygen demand. This oxygen demand depresses hypolimnetic dissolved oxygen levels, especially in the summer. This, in turn, limits the suitability of the deeper part of the harbour as a fish habitat.

Aesthetic quality is diminished by poor water clarity and colour, as a result of high levels of suspended solids, chlorophyll, and dissolved organics, thereby deterring broader recreational use of the harbour.

Significant levels of nutrients, several heavy metals, and PCB in the surface sediments from several portions of Hamilton Harbour. The problem is severe in Windermere Basin. Dredged material is disposed in confined areas.

Objectives are exceeded for total dissolved solids, zinc, ammonia, and phosphorus. Iron, cyanide, and phenolics also exceed the objectives on occasion, especially adjacent to the steel mills on the south shore.

Levels of trace organics (PCB, PAH), phenols in fish under investigation.

ST. LAWRENCE RIVER (Ontario/New York) Map Reference No. 42

NATURE OF PROBLEMS:

Types of Problems	Sources of the Problems
Conventional Pollutants	Industrial Point Sources
Heavy Metals	Urban Nonpoint
Toxic Organics	Combined Sewer Overflows
Contaminated Sediments	In-Place Pollutants
Fish Consumption Advisories	Waste Disposal Sites
	Beach Closings
	Aesthetics

Grasse River sediments are highly contaminated with PCB from past ALCOA discharges. St. Lawrence River sediments contaminated at Grasse River mouth and near Chevrolet Motor Division and Reynolds Metals discharges.
Phenolics and coliform levels continue to exceed the objectives; recreational use of same beaches is restricted.
Alkyl lead emissions from Dupont Canada Ltd. have resulted in elevated organolead in fish.

VI. The RAPs

The RAP program envisions a process by which federal, state and local government agencies cooperate with citizens groups, academic institutions and other interested parties in creating a Plan that will include municipal and industrial wastewater treatment, hazardous waste management, nonpoint source pollution control, groundwater, fisheries and wildlife management, dredging and harbor maintenance, land use and recreation. These Plans have the potential to create a synergy of resources directed toward the common goal of restoring water quality and beneficial uses.

The IJC has the force of an international agreement to encourage participation in the program. This has been greatly strengthened by the Environmental Protection Agency (EPA) Great Lakes National Program Office (GLNPO) efforts to give high priority to the RAP process. With the passage of the 1987 Great Lakes Amendment to the Clean Water Act formally recognizing the importance of the U.S.-Canada Water Quality Agreement, RAP momentum is accelerating.

All RAPs address the following points:

- Definition of the environmental problems from surveillance information.
- Geographic extent of the area effected (including detailed maps).
- Identification of the beneficial uses which are impaired.
- Description of the causes of the problems, including identification of all known sources of pollutants involved.
- Remedial measures proposed to resolve the problems and restore beneficial uses.
- Schedule for implementation and completion of remedial measures.
- Identification of jurisdiction and agencies responsible for implementing and regulating remedial measures.

- Process for evaluating remedial program implementation and effectiveness.
- Description of surveillance and monitoring to track effectiveness of the program and eventual confirmation of restoration of uses (IJC, GLWQB, 1985, p. 44).

Originally the Water Quality Board set a deadline of December 1986 for receipt of all RAPs. However as it became clear that useful plans would require longer to produce the deadlines were extended. To date no new deadlines have been applied.

Some Water Quality Board members state the original purpose of the RAPs was as documentation of ongoing efforts on the part of the jurisdictions. The RAPs evolved from documentation to real plans as public participation in the program expanded.

VII. Examples of RAPs

Green Bay, Wisconsin:

Green Bay has a long history of degraded water quality. Its name comes from the French, "Baye des Pauants" meaning Smelly Bay. The problems are principally due to the fact that the Green Bay watershed drains 15,700 square miles of Wisconsin and Michigan, 1/3 of the total Lake Michigan drainage area.

The Fox River which flows through heavily industrialized areas provides the most pollutants. The Bay has major water quality problems. PCB contamination of the fish closed the once prosperous commercial carp fishery. The sediment are contaminated with a variety of volatile solids, nitrogen, oil and grease, mercury, phosphorus, lead, zinc and PCBs. Nesting terms in the area have demonstrated reproductive failures, and tumors have been discovered in alarming numbers in fish caught in the Fox River. Besides the toxic pollutants, Green Bay also suffers from elevated phosphorus levels, dissolved oxygen depletion during limited times of year, and cultural eutrophication of lower Green Bay.

The Wisconsin Department of Natural Resources is the jurisdiction in charge of clean-up efforts in Green Bay. The DNR has committed itself to restoring beneficial uses by 2000. The Green Bay RAP is being prepared by DNR in cooperation with other agencies and citizens groups.

In Green Bay, significant remedial efforts were already underway before the initiation of the IJC's RAP program. Over $300 million has been spent on water pollution control since 1970. Fish have returned to previously oxygen depleted parts of the Bay but many of the problems remain.

The most significant aspect of the Green Bay RAP developed thus far is the strong commitment of the Wisconsin DNR and the active participation of Citizens Groups. (Hartig, 19).

Hamilton Harbour, Ontario:

Hamilton Harbour, located in Canada at the westernmost point of Lake Ontario is another Area of Concern that is involving local jurisdiction and the public in the RAP process. What is significant about Hamilton Harbour is that the framers of the RAP are attempting to go beyond remediation, toward true habitat rehabilitation. They have also adopted the concept of "stakeholders" to define participants in the RAP.

Hamilton Harbour drains 193 square miles of agricultural land, industry and urban area, into 15 square miles of Harbour water. The Harbour has been critical to the local areas economic development. As part of this development the shorelines has been extensively filled, destroying nearshore life. The sandy bottom has been stripped and dredged: the fish over exploited. It wasn't until the late 1960's and early 70s that industrial and municipal discharges were significantly treated and water quality improvements were made. The harbour still received solids, nutrients and oxygen depleting toxics at detrimental levels.

As in Green Bay the Hamilton Harbour RAP has involved a strong degree of personal, public and political commitment from all involved. (Zarull, 19).

VIII. The RAP Document

Remedial Action Plans are required to take an ecosystem perspective. They are also supposed to be very specific. There is no questions that the causes of the problems in the Areas of Concern, and the solutions are incredibly complex. One of the gravest dangers facing the RAP process is that the sheer complexity, and resulting demands on resources, will become greater than the will to clean up the Areas.

Much of the needed information for RAPs is available only in outdated documents, or is entirely unavailable and must be acquired. Moving from this to a definition of the problem and onto remediation will be an organizational and resource problem of considerable dimensions.

Each RAP will be reviewed for the following:

a. Are the goals and objectives clear and precise? Are they consistent with the general and specific goals of the 1978 Great Lakes Water Quality Agreement?

b. Is the information base sufficient to adequately define the problems and identify the causes?

c. Are the identified remedial actions sufficient to resolve the problems and restore beneficial uses? Are these actions consistent with the stated goals of the RAP? What beneficial uses (if any) will not be restored? Does the RAP indicate why?

d. Is the identified schedule for implementation of remedial actions reasonable?

e. Have the jurisdictions and agencies responsible for implementing and regulating remedial measures been identified?

f. Have studies necessary to complete the RAP been identified and have schedules for their completion been established?

g. Is the proposed surveillance and monitoring program sufficient to document improvements as a result of the remedial actions implemented and confirm restoration of beneficial uses?

h. Has there been adequate and appropriate consultation with the public?

IX. CONCLUSIONS

The New York State Department of Environmental Conservation is responsible for preparing a RAP for each of the six IJC designated Areas of Concern in New York State. The Buffalo River RAP is nearing completion, with a draft expected in early 1989. Oswego River Harbor and the St. Lawrence River at Massena are both at the problem identification stage. The Monroe County government is preparing the Rochester Embayment remedial action plan, which is just getting underway. The Niagara River and Eighteen Mile Creek will be started as soon as the DEC staff complete their work on the Buffalo River RAP (New, 1988). We know our counterparts are well on their way in Hamilton Harbour and Toronto. The Bay of Quinte has some very interesting work ongoing with the role of wetlands in ameliorating water quality problems. There is some potential that Massena may be the first trinational RAP - Mohawk Nation, Canadian and U.S.!

Although the concept of the IJC causing both grass roots action and implementation is novel - it caused a lot of uncertainty about which way to go with planning process as well as technical issues. This is why Remedial Action Forums were held at Windsor, Ontario (IJC, GLWQB, 1986) and at Toledo, Ohio. (IJC, GLWQB, 1987b). Other technical guidance documents were provided as well by the IJC's Great Lakes Water Quality Board (1987a) and the Great Lakes Fishery Commission, Habitat Advisory Board (1986). Although some are optimistic about this grand experiment (Hartig, 1986; New, 1988 and Zarull, 1987) others are more guarded about such possibilities and postulate basic questions about such a process (Boyer, 1988) which makes it all the more fascinating to watch and assess.

The Remedial Action Plan program may have begun to take on a life of its own beyond the expectations of the members of the Water Quality Board who initiated the program. Many organizations from the Great Lakes United coalition of citizens groups, to the Great Lakes Fishery Commission and others have begun to regard the RAP process as the engine that will drive clean up efforts and focus governmental attention on the Areas of Concern. Because of the RAP program's growing importance, and because the Great Lakes constituency is beginning to look to the RAP program as a harbinger of a healthier future, success of the RAP program can have a significant positive impact on the future of Great Lakes Water Quality, the health of the Great Lakes ecosystem and the living things, including the people, that depend on it. However, failure of the RAP process will lead to dashed hopes, reduced credibility for the IJC and a major setback to efforts on the part of the IJC to take an active role in initiating ecosystem improvements.

Whether the RAP program succeeds may depend on how well the Water Quality Board manages its relationships with the governments, and the state and provincial jurisdictions that comprise the membership of the Board. Most observers believe that the success of RAPs will depend on the existence of a political constituency that will assure its funding and implementation. If instigating citizen involvement in the RAP process is a key to its success, will the IJC be able to handle the political repercussions such instigation may entail?

This is from a resolution, adopted 1986. 11.21 by the Water Quality Board of the International Joint Commission, "Protocol for Review of Remedial Action Plans for Areas of Concern"

REFERENCES:

Boyer, B. 1988. Creating, managing and postponing conflict through remedial action plans. In Environmental Dispute Resolution in the Great Lakes Region: A critical appraisal (March 18-19, 1988, SUNY College at Buffalo). L.S. Barker & R.W. Flint, eds.). Great Lakes Monograph No. 1., Great Lakes Program, SUNY Center at Buffalo, PP. 94-110.

Dobson, H.F.H. 1984. Lake Ontario Water Chemistry Atlas. Environment Center, Ottawa.

Environment Canada 1988. Goals, Problems and Options for the Hamilton Harbor RAP. Environment Canada, Hamilton, Ontario.

Great Lakes Fishery Commission, Habitat Advisory Board. 1986. Fisheries information, goals and objectives for remedial action plan. Great Lakes Fishery Commission, Ann Arbor, MI.

Hartig, J. 1986. The Green Bay Experience in Developing a Remedial Action Plan Focus. 11(3):5-6.

IJC 1982. First Biennial Report under the Great Lakes Water Quality Agreement of 1978.

IJC Great Lakes Water Quality Board 1985. *1985 Report on Great Lakes Water Quality*. Report to the International Joint Commission Kingston, Ontario.

IJC Great Lakes Water Quality Board. 1986. Summary of the Forum for Remedial Action Plan Coordinators. Windsor, Ontario, October 20-21, 1986.

IJC Great Lakes Water Quality Board. 1987a. *Guidance on Characterization of Toxic Substance Problems in Areas of Concern in the Great Lakes Basin*. A Report from the surveillance work group based on recommendations from the monitoring in Areas of Concern Workshop held on Canada Centre for Inland Waters. Oct 3- 4, 1984. Windsor, Ontario.

IJC Great Lakes Water Quality Board, 1987b. Summary of the Second Remedial Action Plan Forum. Toledo, OH, November 29-20, 1987.

Jockel, J. T. and A. M. Schwartz. The Changing Environmental Role of the Canada-United States International Joint Commission.

R. Lang and Brooks, A.D. 1987. Integrating quality considerations with land use planning in the Great Lakes Basin. APA environmental planning bulletin, Winter 1987. Vol. 5, No. 1 , pp 3-10.

New, L.A. 1988. Two Points of the Same View Focus. 13(3):15- 17.

Zarull, M. 1987. Remedial Action Plan Process for Hamilton Harbour Breaks New Ground in Ecosystem Rehabilitation of the Great Lakes Focus. 12(1):8-9.

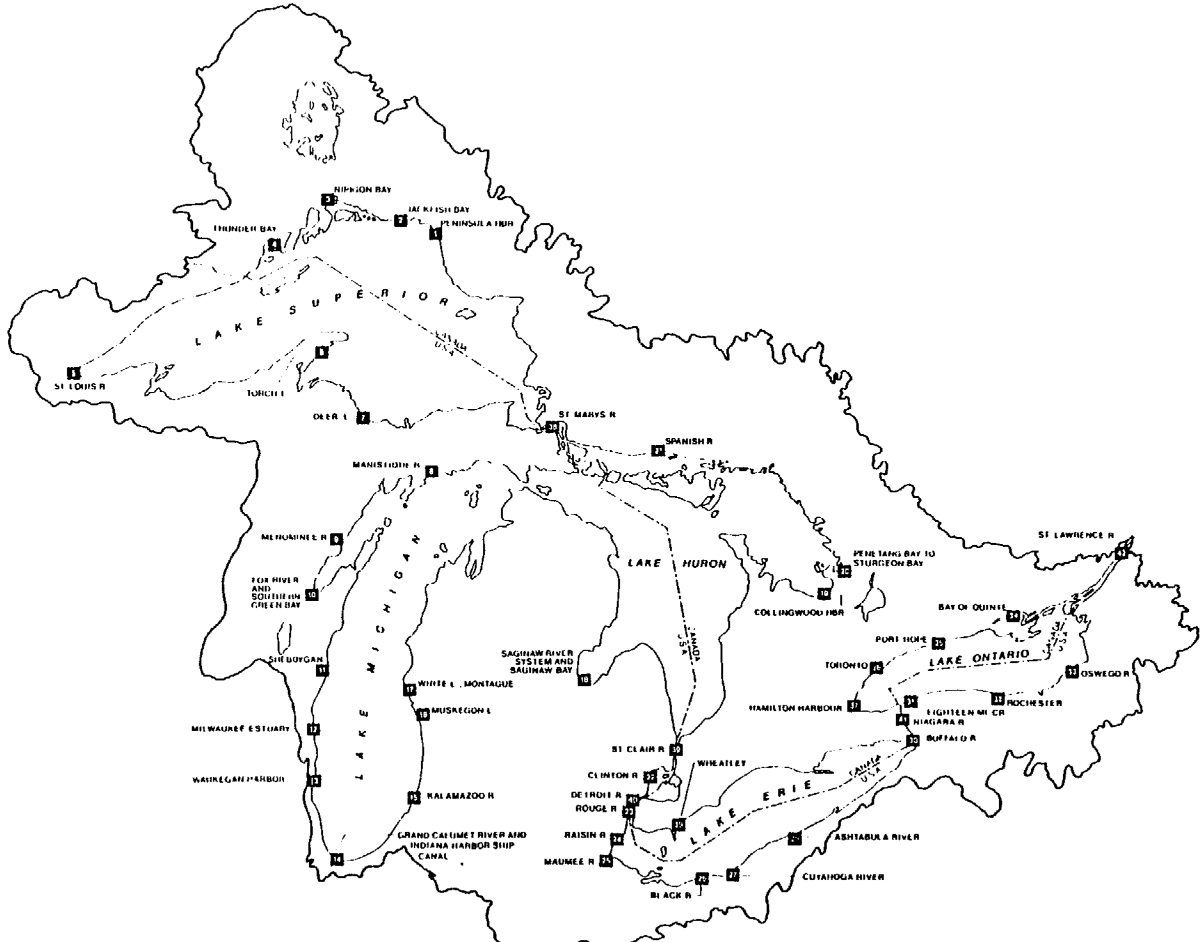
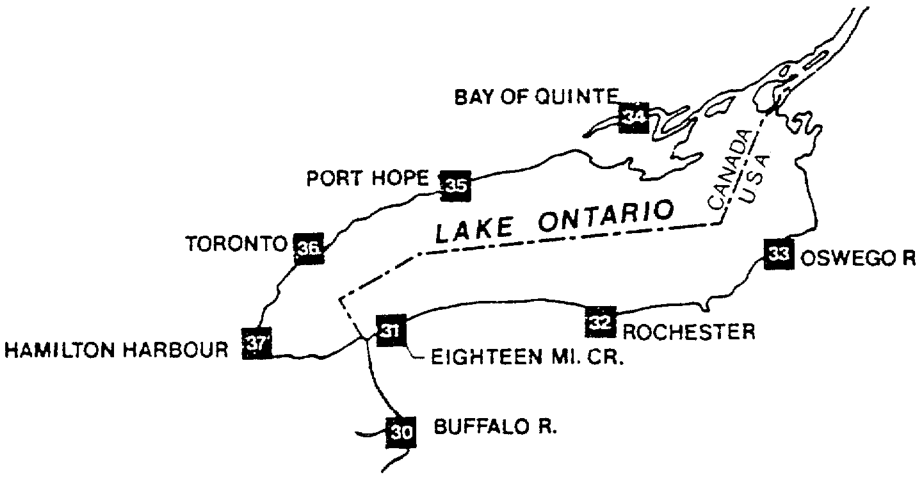
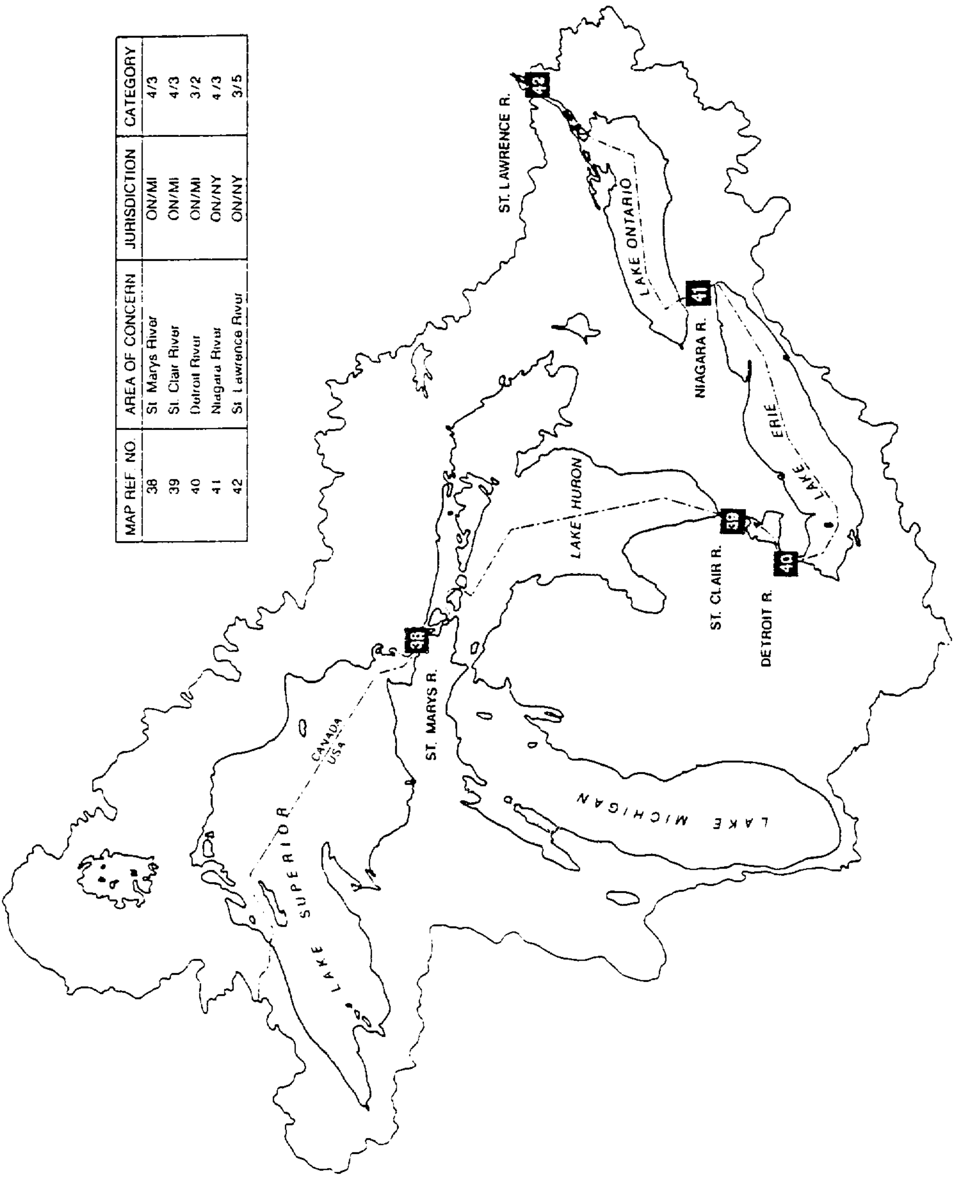


Figure 1. Areas of Concern in the Great Lakes Basin



MAP REF. NO.	AREA OF CONCERN	JURISDICTION	CATEGORY
30	Buffalo River	NY	3
31	Eighteen Mile Creek	NY	4
32	Rochester Embayment	NY	4
33	Oswego River	NY	3
34	Bay of Quinte	ON	4
35	Port Hope	ON	3
36	Toronto Waterfront	ON	3
37	Hamilton Harbour	ON	3

Figure 2. Areas of Concern in Lake Ontario



MAP REF. NO.	AREA OF CONCERN	JURISDICTION	CATEGORY
38	St Marys River	ON/MI	4/3
39	St. Clair River	ON/MI	4/3
40	Detroit River	ON/MI	3/2
41	Niagara River	ON/NY	4/3
42	St Lawrence River	ON/NY	3/5

Figure 3. Areas of Concern in the Connecting Channels

Relative Sea Level Change and Ports

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Background

Sea level change will combine with erosion and climatic shifts to change the future of port management. As waters rise, port environments and associated businesses will be forced to adapt. This paper discusses several of the pressures likely to affect ports beginning in the 21st century, and suggests several tactics to reduce impacts. While the shipping industry may be most interested in direct effects on port operations, another major consideration is the natural environment of port areas. Ports, which are natural havens for valuable coastal resources, may find remedial alternatives limited by the physical perils of rising waters and the ecological threats to marine resources.

The scientific community agrees that sea level is rising. Although predictions of the time scale and precise amount of inundation vary, the inevitability of high waters will affect current and future coastal users. Titus (1986) summarized literature predictions ranging from about 50 to 368 cm (1.6 to 12.25 ft) over the next century. Furthermore, since the causes of relative sea level rise are deeply rooted in global atmospheric and geologic processes (United Nations Environment Programme/U.S. Environmental Protection Agency, 1986), these forces appear inescapable. Our only choices are how we will cope with rising sea level, weighing the financial and ecological burdens of restructuring many major port arenas. For existing facilities, will industry choose to entrench as tidal waters and storms lap at the foot of its physical plant? How will port authorities respond to changing maintenance dredging schedules and the need to retrofit off-loading and storage facilities? If the port industry considers long-term options, they might retreat to higher grounds Unfortunately, since moving from today's waterfront to the site of future shorelines is pure guesswork, retreat also implies significant economic burdens, especially when new construction in valued coastal lands is factored into the equation. For the later reason, businesses must assess the difficulties of wetland and waterway construction in their decisions. These economic, ecological, and political realities suggest that maintaining existing port infrastructure will be immensely complicated, and that we should think twice before adding to those burdens. Over the course of global history, the climatic changes that threaten to precipitate sea level rise are not new (Titus, 1986). Most recently, waters were rising about 3 ft per century between 15,000 and 5,000 B.C. The major difference between than and the predicted amplitude of sea level over the next century will be the implications to our multitrillion dollar port industry. The industrial revolution and human population explosion will ensure that rising sea level affects millions more people and businesses than any earlier climatic event.

Likely Effects

Port regions will be affected by two significant physical pressures—heightened wave surge and saltwater intrusion. These problems could be enhanced by increased storm frequency and severity. Facing threats to safety, health, and economic well- being, industries will be tempted or forced to relocate, thereby triggering secondary threats of coastal construction in a zone already beseiged by human pressures.

Effects on port economies

In addition to the obvious needs for berths and off-loading facilities on the coastal fringe, most shipping industries also use low-lying coastal lands to store products and gear. Most of these properties are protected from the sea by a thin band of bulkheads, perhaps cushioned with sloping rip-rap. In most cases, these barriers extend only 2-4 ft above mean high tide. Very few ports (Providence, RI; New Bedford, MA) have constructed "hurricane barriers" to stem surging storm tides that will crest normal shoreline control devices. Because so many ports are already unprotected from storms and spring tides, we can already catch glimpses of upcoming problems.

One exemplary case was January 2, 1987, when the northeastern United States witnessed an unusual planetary alignment (called a syzygy), and that event coincided with full moon tides and a classic "northeaster" storm. The net effect was tides 3-4 ft above normal, which is roughly equivalent to some conservative estimates of how much sea level may rise over the next century. The visual impact was a startling prelude to what every high tide may present in 2080, perhaps sooner. Piers were overcapped with standing water. Storage areas used by commercial fishermen, container firms, and bulk cargo carriers were awash. Waterfront businesses, may of them non-water dependent restaurants and offices, were flooded. Vessels tied up at their slips were heaved into docks and onto coastal walkways; those once tethered at moorings became dangerous threats to anything in their way. Higher waters reduced bridge clearance to unsafe levels, forcing vessels to idle in rough seas waiting for flooded drawbridges to open. In outer harbors, breakwaters failed to dissipate storm surges that compromised safe harbors and crashed shorefront properties. And associated rains and tidal flows stressed sewage facilities (individual tanks and municipal treatment plants) such that shellfish grounds were closed and many fishermen were left without income. Although the net effect was unquantified, port definitely witnessed the economic burden of higher waters.

Effects on port environments

Besides the effects on port industries and their properties, sea level rise also threatens to alter the physical characteristics of bays and estuaries that often make them attractive harbors and valued ecological units. With higher waters will come a new ecological regime. Physically, water circulation patterns could shift as natural submarine features and man-made structures like jetties yield to the energetics of increased water flows. Geologically, siltation rates could change schedules for maintenance dredging. Ecologically , different atmospheric and oceanic patterns could disrupt delicate migration and spawning cycles that often bring marine resources into port regions. With this new suite of port conditions, remedial measures will be difficult to analyze and alternative sites will appear scarce due to critical data gaps. Basically, without more information, port managers will be challenged to resolve their problems.

Are There Any Solutions?

How can port industry survive such pervasive impact? Even using conservative estimates of sea level rise, these effects seem unavoidable. Hence, the largest port authorities to the smallest harbormasters must begin to plan now.

A rational approach to these problems must involve disciplines ranging from harbor planning to coastal engineering. Possible tactics could include:

Planning

1. Discuss sea-level change with colleagues to increase overall public awareness.
2. Work with governmental bodies and business organizations to ensure that waterfront properties are reserved for waterdependent uses, thereby preserving some options for retreat as sea level rises.
3. Factor sea-level rise into decisions on new construction or remodeling along the coast.

Socio-economics

1. Forecast waterfront trends, including population growth, port usage, public infrastructure, etc. that will affect decisions
2. Conduct port surveys to document the potential effects of higher waters. Develop the information needed to support impending decisions on retreating or entrenching.
3. Review financial situations for the port and affected entities.

Engineering

1. Convert projected impacts into engineering options. Consider all scenarios and alternatives.
2. Factor upland limitations (bedrock outcroppings) and restrictions (public highways or downtown districts) into the process.

This type of introspective analysis could be patterned after basic assessments conducted by the federal government. Although not focused on ports and harbors, the U.S. Environmental Protection Agency (1986a, 1986b) has studied the potential impacts of the atmospheric changes and sea-level rise on several major estuaries. Those provocative reports should entice port managers to think broadly about the future of their home port.

But the most useful document for port managers is the National Research Council's (1987) book on engineering implications. The NRC's "Committee on Engineering Implications of Changes in Relative Mean Sea Level" assessed the response strategies for specific coastal facilities. Discussions offer insightful guidance for operators of airports, transportation corridors, power plants, piers and wharves, docks, and other port sectors. The book also addresses effects on sedimentation, storm drains, water supplies, and other critical aspects of the total port environment.

Literature Cited

National Research Council. 1987. Responding to changes in sea level—engineering implications. National Academy Press, Washington, DC. 148pp.

Titus, James T. 1986. Greenhouse effect, sea level rise, and coastal zone management. Coastal Zone Management Journal 14(3):147-171.

United Nations Environment Programme/U.S. Environmental Protection Agency. 1986. Effects of changes in stratospheric ozone and global climate, Vol. 4 - Sea level rise. Based on proc. of "International Conference on Health and Environmental Effects of Ozone Modification nd Climate Change." Washington, DC. 193pp.

U.S. Environmental Protection Agency. 1986a. Potential effects of sea level rise on wetlands around Charleston, South Carolina. EPA 230-10-85-014. 65 pp.

_____. 1986b. Greenhouse effect, sea level rise, and salinity in the Delaware Estuary. EPA 230-05-86-010. 88 pp.

Mitigating Impacts to Fishery Resources in Ports and Harbors

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NOAA's National Marine Fisheries Service (Noaa Fisheries or NMFS) has statutory responsibility to manage our nation's living marine resources. To accomplish that goal, NMFS operates under the following legislative mandates and authorities: Magnuson Fishery Conservation and Management Act, Endangered Species Act, Clean Water Act, Fish and Wildlife Coordination Act, Federal Power Act, National Environmental Police Act, the Marine Mammal Protections Act, and others.

Ports are an integral part of the nation's economy. They are usually located in estuaries, which provide protected harbors but are often fragile and vulnerable environments. Ports are also essential to our recreational and commercial fishing industries. Without safe harbors to land its catch and maintain its vessels, the fishing would suffer serious economic consequences. These values transcend port size, from small fishing communities like Tylers Beach, Va along our ocean and river coasts to major multiple-use ports such as Seattle and New York.

Regardless of size, ports share many of the same environmental problems. And, since many ports are habitat to valued marine resources, those areas also share a common need to mitigate impacts to common environmental insults. Most ports require dredging for continued access, and require fill to expand terminal sites and other facilities. Dredging creates the need to dispose, and disposal often increases turbidity. Two disposal areas that were bay bottoms but were converted into artificial islands are Craney Island, a 2,500-acre containment site in Hampton Roads, VA and the 1,100-acre Hart-Miller site near Baltimore, MD. Tampa, Fl, among others, has also created islands for its disposal needs, and Boston, MA is now considering an artificial expansion of Spectacle Island in Boston Harbor to dispose several million cubic yards of dredged and excavated materials. Hundreds of estuarine or coastal acres are affected by these actions.

Ocean disposal, whether of dredged material or upland "cellar dirt", poses similar environmental effects. The principal impact is to smother shallow estuarine habitat and to compromise productivity. At Craney Island, a proposed 1,000-acre expansion in shallow estuarine habitat important to living marine resources could have a negative effect on several valued species. Already in the Hampton Roads port complex, approximately 6,000 acres of wetlands and estuarine habitat have been filled for port facilities or spoil disposal.

These trends are typical. Nationally, 50 percent of our wetlands have been lost since colonial times. The rates have been staggering. In Chesapeake Bay from 1950-70, an average of 2,800 acres of wetlands a year were lost. These losses occurred in spite of a legal doctrine that describes wetlands as valuable resources worthy of protection. Fortunately, loss rates have eased since the 1970's.

Wetlands support components of estuarine foods webs which are essential to commercial and recreational fish resources. However, in the absence of long-range planning, current regulatory processes have permitted destruction of important fish habitat, one piece at a time. And the mitigation proposed to compensate for direct losses still remains less science than art. As a result, estuarine production has declined and associated industries have suffered. As more people move toward the coasts, competing demands are likely to exacerbate these trends.

Developmental pressures come not only from maritime industries, which are usually "water dependent", but from diverse"water enhances" interests that wish to locate on the waterfront for aesthetics or convenience. In some locations, active ports are being converted to boutiques, parking lots, and other non-water dependent uses. In addition, proliferating coastal housing has increased non-profit source pollution and has imposed serious demands for sewerage, waste disposal, and potable water.

These stresses have affected living marine resources, particularly anadromous species which utilize most of our Nation's estuaries and associated watersheds. This is especially true for salmon stocks in the Pacific northwest and for depleted stocks of striped bass and American shad in Chesapeake Bay that have been closed to fishing in Maryland. Virginia and the Potomac River Fisheries Commission have taken action recently to protect striped bass stocks in their waters, too.

NOAA Fisheries is concerned about these development trends and our inability to mitigate losses fully. Some of more obvious barometers are serious declines in estuarine-dependent species such as oysters, river herrings, striped bass, and salmons that inhabit port areas or adjacent estuaries. In 1986, estuarine dependent-species represented 70 percent of the commercial landings in the Nation and 66 percent of the dollar value. As the percentage of estuarine-dependent species increases from north to south, mitigation pressures change also. In the Northeast, where 41 percent of the landings are estuarine-dependent, most wetland mitigation is restoring degraded mudflats or compensating for fills with some created habitat; in the South Atlantic and the Gulf of Mexico, estuarine-dependence increases to 96 and 98 percent respectively, and mitigation deals more frequently with salt marsh creation and vegetation planting. In 1986, the commercial value of estuarine-dependent species was $5.5 billion to the national economy, and 17 million marine recreational anglers spent an additional $7.5 billion, yielding a total value of estuarine-dependent species to our economy of $13 billion dollars. These figures underscore the need to mitigate insults to estuaries and port areas.

These threats are why NOAA Fisheries, as the principal steward of living marine and estuarine resources, is involved in mitigating the effects of port activities. We are concerned about harvest management, through the Magnuson Act and other legislation, and with habitat conservation through the Section 10/404 permit programs of the Clean Water Act and River and Harbor Act. Losses of important estuarine and coastal habitats must be reversed to sustain the productivity of our Nation's recreational and commercial fisheries, including the resources, the industry, and their home ports. We must strive for the domestic equivalent of "no net loss" of habitat as mandated in the "Canadian Police for the Management of Fish Habitat", incorporated into fishery management councils' habitat policies, and recently embodied as a national goal by the National Wetlands Police Forum in its late 1988 action agenda. In fact, as the Forum urges, we must strive for a "net increase" in fish habitat to offset losses that have occurred over time.

What can be done to solve these resource use problems that often pit coastal resource agencies and shorefront users against the maritime industry and its constituents? Planning. We must plan for our future water-dependent needs and develop agreements and memorandum of understanding with appropriate agencies. In today's vernacular, we must be "pro-active" rather than "reactive." The Grays Harbor (WA) Special Area Management Plan, Baltimore Harbor Enhancement Plan, and the Philadelphia/Delaware River Plan are examples of rational, proactive planning. Each plan is specific, addresses water dependency, and identifies mitigation methods and sites. The plans should specify that mitigation is part of the developmental challenge; it is not negotiable. We need to follow the basic guidelines outlined by the Council on Environmental Quality; first, we must seek to avoid habitat loss, and, if loss can not be avoided, we must minimize it to the maximum extent practical. With planning, a regional need must be established and a thorough alternatives analysis completed before a port modifies or expands its physical plant. Project designs should be reduced to the smallest practicable dimensions to impose minimal environmental impacts, and we need to make sure that all of these steps have occurred before we consider compensation.

Development projects need to follow a clear and concise decision- making process. Projects must be water dependent and in the public interest. There must be a real need; maritime and municipal interests should not indulge in "port bashing," where each time one port gets a new facility or a new channel, neighboring ports need one to remain competitive. New revenues are usually not general by this process, only shifted along the coast to justify new facilities, attract tonnage, and exacerbate environmental impacts. This process has occurred on the east coast among Philadelphia, Baltimore, and Norfolk for decades. Because of competition for expanded and deepened channels or improved terminals, impacts have been consistent and resource managers have had little opportunity to mitigate port impacts. Two examples of this planning process underscore the benefits of inter-agency coordination and informed decision making. The first example is the Corpus Christi Ship Channel Project, TX. Originally, the project proposed to fill 2,200 acres of Nueces Bay shrimp and finfish nursery area with dredged spoil. As a result of comments received, the U.S. Army Corps of Engineers reduced the fill to 1,200 acres, and subsequently eliminated the fill completely after a hearing organized by the Gulf of Mexico Fishery Management Council. Unavoidable impacts to other habitats were compensated by grading a 200-acre site to wetland habitat and using the graded materials to construct levees around a newly-confined disposal site. The second example is the Navy Homeport Project, also in the Corpus Christi area. Original plans proposed filling nearly 400 acres of shallow water habitat and about 20 acres of seagrass beds with dredged spoils. After inter- agency consultations, the fill was reduced to 1.6 acres of seagrass. Mitigation was provided by connecting a shallow, isolated area on Mustang Island to tidal action followed by seagrass plantings; a 55-acre upland area was also graded and planted with *Spartina alterniflora*. The total mitigation package for the Homeport added 200 acres of estuarine tidal habitat. Both projects minimized habitat losses from port projects.

But why is this process so torturous, and why doesn't it work each time? Thorough mitigation planning is required because mitigation, from administrative processes to track success and the art of creating natural habitats, is still experimental. We can build replacement wetlands, but research is showing that after as long as 15 years they are often not as productive as natural wetlands. In addition, replacing other biotic functions like nutrient exchange has proven disappointing. Still, mitigation/compensation is the only tool we have to replace unavoidable losses, to maintain benefits from productive wetlands, and still accommodate the needs of truly *water-dependent* activities. We can mitigate by constructing wetlands or sea grasses meadows, or we can design and utilize artificial reefs. However, if we are going to use reefs, we must construct "designed reefs," and not build a reef of society's old trolley cars and other assorted debris. This gives rise to a perceived solution to waste disposal—build a reef. We can better plan habitat compensation and restore lost resources by designing and installing appropriate underwater structures. We can also mitigate by restoring degraded habitats and diminished estuarine productivity or by enhancing existing habitat and giving credit for the difference. Finally, some individuals suggest aggressively preserving existing habitat. The latter, from the fisheries perspective, is only partly acceptable since it does not replace the values already lost and since it duplicates protection supposedly afforded under existing law.

A few other guidelines may help port planners. Mitigation should be provided on-site and in-kind, as opposed to some other location and some other habitat type. When that is not practical, the best alternative should be sought. Mitigation can be provided for either a single project or it can be designed as part of a harbor plan and banked for future work. In designing and providing mitigation recommendations, we need to establish clear values to be replaced. This allows us to identify our target and establish a measure of success. Initially, the measure of wetlands mitigation success was simple. If the plants grew and stayed green, we were successful. Now was are finding that there's much more to mitigation than vegetative success; all vital wetland functions should be re-established. In addition, we need to build an administrative process to monitor these projects and to deal with failure. If initial mitigation attempts fail, there must be a mechanism available to rectify the situation, and to specify how many planting seasons or regarding attempts will be required before final "success" is measured. We also need to establish the rules for mitigation banking, which govern when and how you can withdraw habitat values and the accounting system that will define and track those withdrawals. Debits would be based on the ecological values of the mitigation site compared to wetlands proposed for development.

All mitigation projects must have a well-designed experimental or monitoring program to assess overall effectiveness. Results will improve the effectiveness of future mitigation projects, and allow managers to adjust plans.

We need to consider innovative solutions to port problems. NOAA Fisheries now has a cooperative program with the Corps of Engineer looking at the possible beneficial uses of dredged material. The agencies have collaborated on an artificial reef in Mission Bay, CA, as part of a jetty restoration project, on several experimental shellfish habitat projects in Chesapeake Bay, and on one in Everett, WA utilizing dredged material. One project in Coos Bay, OR, is reclaiming a former wetland that had been converted to agricultural use. While these experiments offer some encouraging results, all parties must be very careful when applying the lessons elsewhere.

In closing, please recall the importance of NOAA Fisheries' efforts to maintain aquatic productivity. The agency is involved so that we can have both a clean and healthy environment for future generations, and so that these environmental principals do not become undue obstacles for the economic expansion necessary to move our nation into the 21st century. If we don't accept and conquer this challenge, future generations might pay a far greater price, especially peoples relying on the seas for sustenance and recreation. Just as we now recognize the effects of industrial expansion on the greenhouse effect and short- sighted disposal practices on hazardous waste problems, so must we recognize the cumulative adverse impact of piece-meal development on our coastal zone/estuaries and the resources they support. We must devise methods to overcome those losses.

If we do this together through cooperative long-range planning, we can succeed in achieving these goals.

Acknowledgment

We would like to thank the members of NOAA Fisheries' regional habitat programs who contributed information and examples to this manuscript: Ted Myers, Alaska; Einar Wold, Northwest; Don Moore and Rick Ruebsamen, Southeast; and Mike Ludwig, Northeast.

MARINAS & PUBLIC ACCESS

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Marinas Are Major Access Points For The Public

Key to a full and balanced discussion of public access to the water is an understanding of the vital role that marinas provide as the major boating access points.

What is a marina? The State of Rhode Island Coastal Resources Management Program uses the word "marina" as a broad generic term to refer to "any dock, pier, wharf, float, floating business, or combination of such facilities that services five or more recreational boats as a commercial enterprise or in association with a club." As one who helped create that definition, I agree that is a good practical way of functionally defining a coastal structure. The program goes further by finding water dependent "Marinas are the principal means by which the boating public gains access to tidal waters, and therefore provide an important public service. Only beach going involves more Rhode Islanders in a recreation activity that makes direct use of tidal waters" (Olsen et al., 1983).

Marina Definition. The International Marina Institute, however, uses the world "marina" in two ways . . .

a. Narrowly a "marina is any docking facility (public or private) with ten or more slips, moorings and/or dry rack boat storage which has waterfront access." This is the definition used by the Institute in the US National Recreational Boating Facilities Inventory (Ross, 1988).

b. Broadly a marina with slips, moorings and/or rack storage can also include a boatyard (some places called shipyard) that services and repairs recreational vessels, the private yacht club, the dockominium, and the publicly owned marina park (Ross, editor, 1988). In short, in the broadest sense any recreational boating facility could be generically called a marina.

The common element in our definitions is that all these marina facilities provide the same thing—access points, where people go to gain access out and back from the water on a boat.

A significant number of people go boating. Brown University's Narragansett Bay Project study two years ago documented that one third of Rhode Island's population goes out in a boat every year (Ward et al. 1987). That's quite significant; and politicians listen to statistics like that. Contrary to the myth that they're all rich, boaters represent a fairly broad cross-section of the population. Dr. Niels Rorholm (University of Rhode Island resource economist emeritus) studied boat ownership patterns in RI and concluded that there was no direct relationship between the value of the vessel and the income of the individual who owned it (Rorholm, 1976). He found that some fairly expensive boats were owned by people who's income suggested that they couldn't afford the boats; and others, who were fairly well-to- do, owned very modest priced boats. Boating, therefore, seems to cross cut most of socioeconomic levels within the state.

Economic Impact of Boating and Marinas as Big

The National Marine Manufacturer's Association (the major trade association representing the boating industry) estimated that in 1987 all of recreational boating in the United Sates represented $16.5 billion at retail (NMMA, 1988). During 1986 and 1987 the author, with a coordinated nationwide team of 35 researchers, telephone interviewed 8,611 marinas, boatyards, yacht clubs, dockominiums, and public marina parks across the country as part of a national inventory of boating facilities. From the data collected, I project that the boating facilities represented a gross annual income of $7.5 billion. Therefore, half of the money that goes into recreational boating as a national industry, enters at the waterfront. That's significant economic impact.

Two Kinds of Access

To understand the role of marinas (broad definition) in terms of access, it is very important to make a distinction between two kinds of access: public access, and access for the public.

Public access is free access at will for the general public; any place where the public has a right, at any time they want, to get to and from a particular area. Public access means being able to reach the water with little or no restrictions. Public launching ramps, fishing piers, and state beaches are good examples of public access at will. (Ross, editor, 1988)

Access for the public means controlled access for the public with some limitations and/or costs; points where there may be conditions which limit access, such as times when you can gain access, a charge, or how you may gain access (e.g., owning a boat, going with another who owns the boat, or buying a ticket for a ride). All citizens, whether boat owners or guests, a members of the public. For example, no marina, whether it be a publicly owned town dock or a privately owned marina, can have public access out onto the docks at any time. Who's going to pay for the liability insurance for people falling and tripping? Who's going to provide security for the boats against theft or vandalism? (Ross, editor, 1988)

In the same sense boatyards can't allow public access into work areas or where boats are stored. It's dangerous and there's a major security problem, so there must be restrictions. Where there are restrictions then we must refer to access for the public.

Cost of access is just one part of a continuum of variables which restrict or target any access. For example, New Jersey now requires all swimmers to go to local police stations to register and pay for male or female beach passes, and anyone found on a beach without wearing one is liable to eviction. Clearly New Jersey is making it difficult for nonresident tourists to use the "free" coastal beaches. In South Kingstown, Rhode Island, a "free" public boat launch ramp with a $15 per day parking fee scares off many boaters. On the other end of the spectrum, members of the public who chooses to buy dockominiums slips for their boats at $2,000 per foot, plus annual management and repair fees, gains access to the water but at a very steep rate, and has the right to resell that "right of access" for whatever the market will bear. Cost does not restrict public access, but it doesn't prevent access for the public.

Ten Thousand Boating Facilities in USA

In our 1986-87 national study of boating facilities (Ross, 1988), two of the questions we asked are "Who owns the land?" and "Who owns and operations the facility?" It may surprise many people in and out of government to learn that we estimate that the total marina population is just over 10,000 boating facilities publicly and privately owned in the United States, with 87% of them privately owned and operated.

Hourglass of Boating

I want to talk about the hourglass of boating access. On one side of the glass we have the waters of our nation—ponds, rivers, lakes, bays, estuaries, etc. On the other side, is the sand are the families who want to go boating. To gain access, the family must go out through a launching ramp or a marina . . . the narrow neck of the hour glass. Eighty-seven percent of the marinas in the United States are privately managed, thus the private sector provides major access for the public to go boating.

Those private marinas already exist at no cost to the taxpayer, and are wholly paid for by the user. Marinas are providing access across private land that otherwise the public would not have access to. In my own state of Rhode Island, 96% of the boating facilities are privately owned and operated. Without them the one third of the state's population which goes boating each summer would have very little access to the water.

Marinas in Coastal Areas Are Changing

Most existing boating facilities were built in the 1950's and '60's, and they're getting old. Most were dredged and now need maintenance dredging. Many of the east coast states have slip shortages which are limiting boating access. The return on the private marina investment, up until about 8 years ago, was a negative number. That's changing for the positive side. But today, every with increases in prices and costs marinas are still not returning profits as expected for other kinds of business.

Boats, in addition, are bigger, longer, and wider as compared to the typical boat ten years ago. Because they're bigger, most marina slips are too narrow for the boat population they serve. Something has to give. One of the things that's going to change is that there will be fewer boats per acre in marinas and the cost will go up.

Trends in marina ownership and management are interesting. There is what I refer to as a "push-pull" going on which is resulting in the sale of marinas. Marina growth in the Northeastern states is in irons (a dangerous situation when a sailboat, not moving forward, is sailing backwards and is hard to control). Marina growth is somewhat in irons. They're moving backwards, in their opinion, by being pushed out of business from the sheer frustration of dealing with government inaction and permit blockages. There are several reasons for this backwards slide.

Some states have generally defaulted with an attitude toward boating facilities: "Let the rich boaters take care of themselves. State governments shouldn't get involved encouraging private marina growth or development," some say. Read your State Comprehensive Outdoor Recreation Plan (SCORP) to see how much space is devoted to recreational boating. I'll bet it's less than a page, and in some states, it's about a paragraph. In Rhode Island (until the last revision in 1987 which I participated in) boating was handled in two sentences, yet in that "Ocean State" almost every tourist brochure shows a sailboat.

The ultraconservative marina regulations by government agencies, I believe, stems a basic feeling of being insecure. When people don't understand what they're dealing with (e.g., a marina), the natural reaction is to back off from making a decision, postpone action, and put it at the bottom of the work pile. Today there is much more information about marinas available from Sea Grant sources and the International Marina Institute. There's no need to remain insecure and to do nothing.

There's a common misperception that private marinas do not provide public services. Marinas do provide significant access to the public to boating waters. In addition, there are also many unrealistic and negative environmental claims about what marinas do or don't do. One should not ignore the large number of documented environmental, social, and economic benefits that marinas provide.

The excessively slow permit process often leads inexorably to sheer frustration, forcing marina owners to want to sellout. Lack of practical guidelines by state coastal planning organizations thwart modernization or maintenance of the facilities. When property taxation at the local level is for the "highest and best use" (meaning: the highest tax rate we can have) marina land gets valued at condominium development rates. That condo value has no relationship to what the boating business itself is doing.

All of the above appears to be pushing people out of the marina business. But there is another force which is pulling them out of business. . .

In Rhode Island I predict that 50% of the marinas are going to be sold in the next 8 years. 50% of the 97% of the boating facilities are going to be sold. Who's buying them? They're being pulled out of the business by real estate developers who are bidding the prices upwards well above the actual value of the business. And a common, not unusual scenario is for a developer to approach a marina owner and say: "You've got 4 acres of land, you've got 150 slips, you're 64 years old, you've been in this business since 1956—I'll give you $4 million for your business." And this marina owner has been waiting four years for a permit to rebuild the bulkhead and knows that he can't dredge because there is no approved disposal site. He turns to his spouse and says "We can retire as millionaires, four times over." That's a big force which is pulling marinas out of the business and it can't necessarily be stopped or prevented. What will each state do to replace those lost marinas and boatyards?

Some other management changes that are happening. **Mom and Pops marina owners** are not out, but they are changing and modernizing. There are new Mom and Pops coming into the business. People in mid-life are changing careers away from Wall Street, top levels of corporate, or government agencies, and moving into marinas.

Marina chains are evolving. No longer are all facilities owned by individuals, but marina chains are growing. For example, the second largest marina chain in the country is the Brewer's Boatyards with 14 full-service marinas and boatyards. There are corporate takeovers.

The largest is Public Storage Corporation out of California doing business as Westrek. Their plan is to own 40 to 100 marinas around the United States. They sell limited partnership stock as investments in marinas. They now own and operate over 20 marinas.

The newest change is the dockominiumization of marina slips. What are dockominiums? They come in several forms. First, there's the one that actually sells the slip. Second, there's the cooperative marinas, like the cooperative apartments in New York. Third, the long-term lease—typically for 99 years. Here's an interesting coastal policy question: "Can you lease something for 99 years if the state only gave you the right for 50 years to use it?ø That's one the Attorney General in Rhode Island hasn't yet decided on. The International Marina Institute estimates that there are about 300 dockominiums in the United States, and over the next five years should increase to about 600 more bringing the number of dockos up to about 1% of the boating facility population. The average selling price 2 years ago was $1,000 afoot for the slip, and smaller sized slips generally are 30, 40 foot and 50 foot slips are preferred. Now the average price nationally ranges between $1,500 and $2,000 a foot.

We held our second national dockominium conference August 1988. Dockominiums are, in my opinion, an answer by the marina industry to the law of supply and demand, plus a response by some marina owners, who are saying "Why should we, after 20-30 years building this facility up, sell it off to a land developer who's going to convert it into something else, and is going to walk away with millions of dollars in his pocket. Why can't we have the millions in our pockets AND lock our marina into continuing to provide access for the public?" Are dockos restricting public access? Go to any marina that's in the process of converting and photograph the boats in slips before it's sold; then, after it's sold, go back and photograph it again. It's highly probable that 80% of the boats will be the same and in the same slips. It doesn't mean that they've bought a slip—they may still be renting a slip—about 40 of the people who buy docko slips do so for the investment purpose, not to put their own boat in it. So those slips will continue to be available for seasonal rentals and for visiting or transient boats.

Is privatisation of the waterfront hurting? Yes and no. **Yes,** it's hurting whenever a marina is bought out, converted into condo housing, and then shrinks the number of slips available. In that case there's a net loss of access. **No,** it doesn't hurt, but can help access for the public when a new dockominium is built in an area where there is limited boating access, thus increasing the number of places for people and families to go boating. That increase would generally help. Dockominiums will do well where the demand exceeds the supply of slips in those states which continue to frustrate marina modernization and growth. Dockos do not sell well in those states which allow marinas to expand with the demand.

State coastal management has several options available.

1. Plan to establish water-dependent districts in the state. Involve the marina industry in that planning process.
2. Define the benefits of having marina access in each area and expand coastal plans to clarify the marina issue.
3. Protect the existing water-dependent uses.
4. Streamline the marina permit process.
5. Solve the dredge material disposing question. Come up with some alternatives.
6. Help control access by encouraging the expansion and modernization of the existing facilities. We can't afford to replace them—let's at least allow them to do better.
7. Facilitate the building of new marinas, especially in those areas where there is very little access to the water such as in urban waterfront.

8. Purchase the development rights and allow marinas (similar to farms) to stay in business (see Massachusetts for its law on this).

Summary

There are eight characteristic of the leading states with healthy marinas in the decade ahead.

1. These states understand and use the concept of the hourglass of boating.
2. They publicly recognize the significant public benefits provided by marinas both public and private. Not favoring the public over the privately operated one.
3. Put marina access and facility development high on the list of state actions. Action doesn't mean on paper. Action means you do something.
4. Sharpen coastal management planning through direct two-way input with marina owners.
5. Those states will functionally simplify their permit process. There's no reason why somebody has to wait four years just to rebuild a bulkhead that had already been permitted.
6. Promote marina modernization, expansion and maintenance.
7. Reverse the push-pull forces that are working to sell out those private marinas into non-water-dependent uses.
8. Protect the consumer's rights—the boater's rights—while allowing the private marinas and the public marinas to make reasonable profits.

A final comments, I'm bullish about marinas . . . the key to present and future recreational boating. I'm also bullish about the willingness of government agencies to encourage boating growth. It's in the best interest of the public to preserve and protect the marina businesses as providing significant benefits to society. **Remember, in each state, the future of boating and access to the water will be decided one by one, incrementally, on each shore, in each marina.**

References

NMMA. 1988. *Boating 1987, A Statistical Report on America's Top Family Sport.* National Marine Manufacturers Association, Chicago, IL.

Olsen, S. and G.L. Seavey. 1983. *The State of Rhode Island Coastal Resources Management Program, As Amended.* The Coastal Resources Center, University of Rhode Island, Narragansett.

Rorholm, N. 1976. *Boats and Their People: A Study of Rhode Island Boat Owners.* University of Rhode Island, Technical Report #52.

Ross, N. 1988. *U.S. National Recreational Boating Facilities Inventory.* International Marina Institute, Wickford, R.I.

Ross, N., editor. 1988. *Marina Dictionary.* International Marina Institute, Wickford, R.I.

Ward, H., L. Kossin, and M. Brown. 1987. *User Perceptions of Narragansett Bay.* Center for Environmental Studies, Brown University, Providence, RI.

The Evaluation of Minimum Detectable Impacts in Environmental Assessment Studies

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Abstract

Strategies have been developed for statistically defining "impacts" in environmental assessment studies. A series of techniques have been developed to estimate "minimum detectable impacts" (MDI's) for variables examined during the baseline phase of trend assessment studies. In order to demonstrate the application of these techniques, a study was conducted on a baseline data set collected during a 3-year pre-operational monitoring program in the vicinity of a municipal wastewater discharge in Hampton Roads Harbor, Virginia. The benthic biological and chemical data sets were evaluated by MDI models based upon χ^2, ANOVA, MANOVA, and nonlinear regression techniques. The MDI values for most of the chemical sediment quality data were moderate, allowing the detection of potential impacts before the levels of change would become a major "ecological significance". However, the natural spatiotemporal variability of the benthic biological data sets allowed only certain of the statistical models to detect important changes, involving the complete loss of major taxa. The evaluation of MDI values were demonstrated to provide: 1) "red flag" warning levels for the "real-time" detection of potential impacts; 2) an indication of the sensitivity (and defensibility) of the sampling/statistical regimes;and 3) a mechanism to optimize the experimental design of future investigations in order to provide a sensitive and cost-effective post-operational trend assessment program.

Introduction

Scientists developing environmental monitoring programs must consider the ultimate question: "Has a significant impact occurred?" This question represents a primary concern of environmentalists and regulatory agencies alike. Therefore, the investigator must design baseline and trend assessment studies in such a way as to allow detection of environmental impacts. In order to properly address this question, the investigator should have a basic definition of a "significant" impact. This definition has two components: 1) "What is a *statistical* impact?" and 2) "What is an *ecological* impact?" In order for an impact to be demonstrated to be of ecological significance, it also should have statistical significance. However, the converse is not necessarily true. In fact, it would be desirable to design a monitoring program which would allow the statistical detection of ecological changes before they become critical.

The sensitivity of statistical detection depends upon a number of factors including the power of the model being employed, the number of replicate samples and the natural spatial and temporal variability of the parameter being evaluated. The present study describes strategies for defining impacts for an environmental monitoring program. Specifically, a series of statistical approaches have been developed to estimate "minimum detectable impacts" (MDI's) for variables examined during the pre- operational phase of a monitoring program in the vicinity of the outfall of a sewage treatment plant. The sensitivity and robustness of various statistical models were evaluated in the context of the natural variance structure of sediment quality data sets consisting of a variety of biological, chemical and geological parameters.

Methods and Materials

Study area

A pre-operational environmental monitoring program was conducted in the vicinity of the outfall of the Nansemond Treatment Plant (NTP) in Hampton Roads, Virginia from March 1979 through January 1983. The study area was located in the lower James River estuary near the Chesapeake Bay and centers on Hampton Roads Harbor, one of the largest natural harbors in the world (Figure 1). Fourteen collection stations were originally established at various distances from the plant's 61 m, 40 port diffuser. Station 1 was located over the diffuser. Other collection stations formed concentric circles around the outfall: at distances of 400 m (Stations 2, 3, and 4), 800 m (Stations 5, 6, and 7), and 1600 m (Stations 8, 9, 10, and 11). Station 13 was located at 2850 m from the outfall. Two stations (12 and 14) were dropped from the study early in the sampling program due to qualitative differences in sediment characteristics and macrobenthic community structure, probably due to the effects of the James and Nansemond Rivers.

Field and laboratory methods

Details of the collection regime and analytical methods are presented in HRSD (1984). Sediment collections were made during summer and winter months. A $0.052 m^2$ Ponar grab was employed to retrieve substrate for geological, chemical and biological analyses. Sediments were analyzed for cadmium, copper, lead, mercury, zinc, TKN, pH, organic carbon, and percent volatile solids. Collections used for taxonomic analysis of macrobenthic community structure were sieved through a 0.5 mm screen and fixed in 10% formalin, with rose bengal added to facilitate sorting. In the laboratory, macrobenthic organisms were sorted, identified and enumerated to the lowest recognizable taxon. Community biomass for each grab was determined by the ash-free dry weight method (Crisp, 1971). Sediment size analyses were conducted following methods described by Folk (1974).

For purposes of the present study, the results of MDI evaluations on sediment quality data will be used as examples. However, the results of MDI evaluations on all data sets displayed similar patterns.

Statistical methods

The data sets were evaluated for MDI's using a number of statistical models. The simplest model involved identification of the magnitude of difference required for a variable in a single sample before a statistically significant impact can be inferred. A related model involves impacts on multiple variables in a single sample. The third model involves an ANOVA test of the effects of the spatiotemporal interaction. An analogous MANOVA model was used to test the significance of the multivariate spatiotemporal interaction. Finally, a nonlinear regression model was evaluated as a test of the relationship of the degree of impact to proximity to the outfall.

Prior to the MDI evaluations, each variable was transformed by a procedure based upon the power series transformation by Box and Cox (1964) prior to the analyses. This transformation employs a maximum likelihood procedure to optimize the "normalization" of each variable as well as providing a stabilization of variances. Thus, statistical procedures were conducted on transformed data that are as nearly "normal" as possible. Greater power (lower MDI's) is generally achieved with data transformed by this procedure than with raw data.

The robustness of several models were also evaluated. In these tests, untransformed data were employed for "worst case" assessments of robustness of the statistical models.

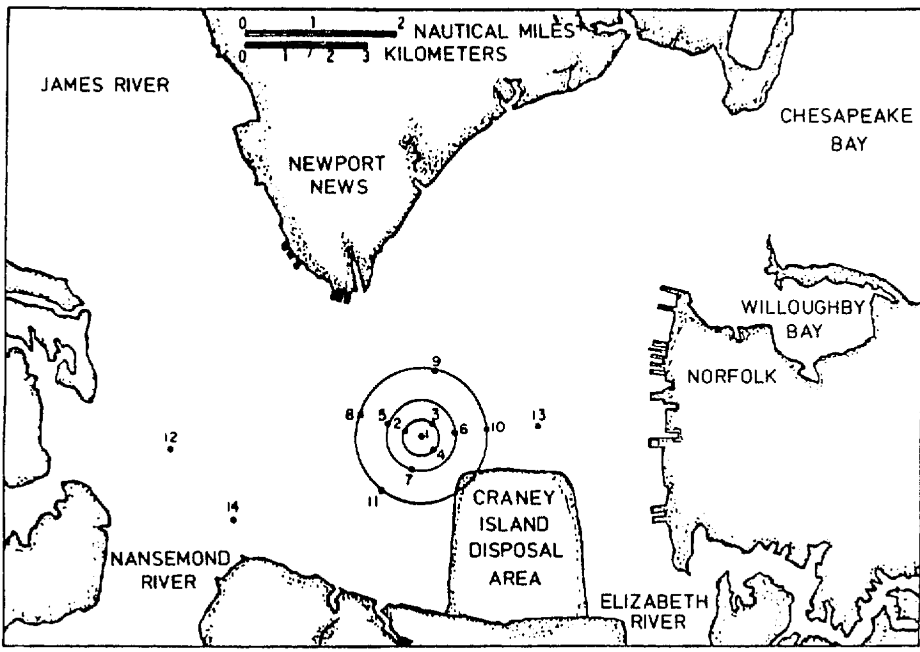

Figure 1. Study are in Hampton Roads Harbor. The study area is located approximately 30 km west of the mouth of the Chesapeake Bay.

Single sample model. The general approach to calculating single sample MDI's is based upon a method described by Green (1979). Green suggests that statistically significant outliers can be detected through an evaluation of samples against the context of the variance-covariance structure of the baseline data set. The method involves the use of a chi-square (χ^2) test of variables in a sample employing the following equation:

$$\chi 2 = (X_j - X_j)\, D^{-1}\, (X_j - X j) \tag{1}$$

where X_j is the value of the sample observation, $\bar{X}_j$ is the baseline mean or expected value of the jth variable, and D is the variance-covariance matrix.

If the sample being tested is sufficiently divergent from the original data set, equation (1) will produce a χ^2 value greater than the critical test level. This equation can also be used to calculate single sample MDI levels.

A computer program was developed to add or subtract factors (i.e. small proportions of the means) incrementally to the means of each variable. This program was coupled with the χ^2 test (equation 1) to evaluate iteratively the effects of increasing or decreasing the values of each variable. Each variable was evaluated sequentially, with all other variables remaining constant and equal to the means. The factors were increased incrementally for the variable being tested until a significant χ^2 value was obtained. The factors producing significant effects were considered to be the MDI levels.

Multiple variable/single sample model. It is quite likely that more than one variable would be impacted simultaneously during any major environmental perturbation. The amount of change needed in any variable would be expected to be considerably less. A second computer program was developed to provide an evaluation of the effects of multiple impacts on the level of change required for statistical detection. Each testing series consisted of the evaluation of data sets for which the values of various combinations of randomly selected variables were changed by factors from 10% to 100% of the single sample MDI levels. Series were tested for 2 variables, 3 variables, ... all the variables in the data set being impacted at the same time. Ten replicate runs of each series were made. The mean values of the χ^2 values were plotted against the percent impact for each combination of variables. The points where these lines cross the critical χ^2 level represent average mixed impact, single-sample MDI's for each combination of variables.

The results of these evaluations can be formatted into tables of "red flag" values which may be used by laboratory or field technicians prior to formal statistical analysis to determine whether values or combinations of values should be considered statistically significant. Such tables can be used for signaling quality control checks or the initiation of intensive investigations into the magnitude and ecological significance of the impact.

Spatiotemporal interaction model. The most common circumstances for the examination of data for impacts involves the collection of multiple samples in a trend assessment study. A two-way analysis of variance (ANOVA) was employed to account for spatial and temporal effects before the spatiotemporal interaction effort is tested. The interaction represents any changes observed in the impact zone that cannot be explained by spatial or temporal patterns.

The MDI's for this model were determined by randomly selecting samples from "impact" (Stations 1-4) and "control" (Stations 8-11) areas at various levels of replication and introducing "impacts" (i.e. adding or subtracting small proportions of the means) to the "after-impact" data set incrementally until a significant test was obtained (i.e. MDI is reached). The tests were repeated five times at each level of replication and the MDI relationship to sample number plotted for determination of optimal sample size. The entire process was repeated for each variable.

Multivariate spatiotemporal interaction model. As previously indicated, impacts on single variables during major environmental perturbations are unlikely. Rather, groups of variables would be expected to be impacted at once. One could speculate which variables are most likely to be impacted together based upon past experience or information from the literature. However, such an approach is subjective and may not reflect unique aspects of potential impacts. Therefore, a conservative approach was adopted whereby impacts were introduced into combinations of randomly selected variables (e.g. 2 at a time, 3 at a time ... all variables at a time) in incrementally increasing magnitudes (i.e. as a percentage of individual MDI's). A multivariate analysis of variance (MANOVA) was employed to test the spatiotemporal interaction effect in each run. The test was repeated five times for each combination of variables and level of impact. The results of these tests were plotted to determine the levels of impact (% of single variable MDI's) that were necessary for statistical detection when multiple variables have been impacted.

Nonlinear regression model. In a situation involving a point source in an open body of water, potential impacts may be expected to be related to the distance from the discharge in a nonlinear manner. Because dilution of the effluent is related to the volume of the mixing zone at any given distance and this volume is related to a function of distance squared (i.e. area) when the depth is a constant, potential impacts may be expected to display a relationship to the reciprocal of the distance squared. Thus, if an impact of 1 arbitrary unit is observed at the discharge (D=1), then the impact at D=2 would be 1/4 of that level, at D=3 would be 1/9, ..., etc.

The nonlinear regression model employed a transformation to linearize this impact relationship to distance:

$$D^* = [2D^2-1]/[D^2] \tag{2}$$

where D^* is the transformed distance and D is the distance from the discharge, with the following conventions: all distances are standardized by (divided by) the smallest distance; and 1 is added to all D values so a station at the discharge may be included.

The sensitivity of the model is tested by randomly selecting samples from each distance from the baseline data set at various levels of replication and performing a nonlinear regression analysis using the equation 2 transformation. A second analysis was performed on a data set to which "impacts" had been added in proportion to $1/D^2$. The difference between the two regression equations were evaluated by 1) a comparison of the slopes; and 2) by a t-test of the values predicted for the discharge station (i.e. D=1; analogous to a test of intercepts). If the tests were not significant, the impacts were incremented and the tests rerun. The MDI's were defined as the level of change predicted for the discharge when a significant test was obtained. The MDI's were determined for five replicate runs for each level of sample replication per distance.

Tests of statistical robustness of models. The robustness of the multivariate interaction and nonlinear models were evaluated by multiple runs of tests of populations into which no impacts were introduced. In the case of the MANOVA interaction test, "after- control" and "after-impact" data sets were simulated 250 times with no introduced impact and tested. The nonlinear model tests were run based upon "bootstrap" selections of data (see Diaconis and Efron, 1983) from various distances to create 1,000 comparisons (slope tests and t-tests of predicted discharge zone "intercepts") of "before" and "after" data sets to which no impacts had been introduced. The observed alpha values were plotted against nominal values for determination of the relative robustness of the models.

Results and Discussion

Single sample model

Figure 2 presents the results of the single sample model for the data set containing chemical and biological results from benthic collections. An evaluation of the MDI's and the absolute levels of the impacted variables suggested that an impact could be detected in approximately 1/3 (open bars) of all variables at levels below those which may be considered to be ecologically significant. The MDI's of approximately 1/2 (single cross-hatch) of the variables were above the levels of impact that might be deemed to be ecologically significant. The analyses of the remaining variables (double cross-hatch) produced no MDI's: cadmium in sediment values were so "noisy" that an impact 5,000 times the baseline mean could not be detected; volatiles in sediments displayed an MDI that produced an impacted value that was over 100%; and the MDI for biomass of benthic macrofauna was more than 100% reduction (i.e. complete loss of biomass could not be statistically detected). The benthic taxonomic data sets were also quite variable (mean coefficient of variation = 326%), so no single sample MDI's could be calculated for abundance data for any of the taxa (i.e. MDI's >100% reduction in numbers).

The multiple impact/single sample model for the same data set indicated that for lower magnitudes of change in the values of individual variables were required when more than one variable was impacted at the same time (Figure 3). When more than 3 variables were impacted at once, the levels of change required for statistical detection were only 30-40% of the single variable MDI's.

These patterns allowed the construction of a table of "red flag" values (Table 1). As an example of how this table may be used, a technician may discover a zinc in sediment reading of 300 mg/kg and find from the table that this single reading is outside the 0.01 probability limits of the baseline data (X=91 mg/kg). The technician may then perform a quality control check on the analysis. If the results appear valid, a planned contingency response may be implemented. Such a response may include the analysis of additional (archived) samples, the collection of new samples from the same area to confirm and better define the contamination pattern, or a full ecological assessment involving body burden and toxicological surveys of the region. If several metals had appeared elevated at once (e.g. Column 5, Table 1; [Cu] >71 mg/kg, [Pb] >53 mg/kg, and [Zn] >59 mg/kg), then similar response actions would be initiated.

Spatiotemporal interaction model

The results of the spatiotemporal ANOVA model for variables from the sediment quality data set are presented in Figure 4. The histogrambars represent the mean values of MDI's from five runs of the model with the number of replicate samples in control and impact areas being equal to that of the pre-operational sampling regime (n=12 in each zone). As might be expected, the MDI's of the spatiotemporal models tended to be lower than those of the less powerful single sample models. MDI's could be calculated for all sediment quality data and the MDI values for the chemical data were below those which may be considered to be ecologically significant. However, the more variable biological data produced MDI's which were within the range that might be considered to be ecologically significant. MDI's could be calculated for only 3 of the benthic taxa from the winter data set and only

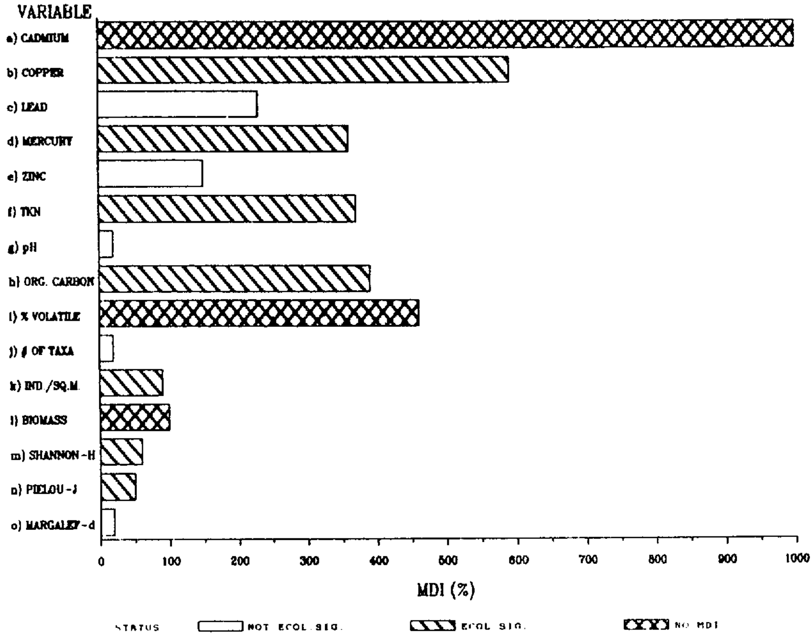

Figure 2. MDI's for sediment data employing snigle sample models. The open bars are values determined to represent levels of change that were not considered to be ecologically significant; the single cross-hatch bars are MDI's for which the level of change is considered to be ecologically significant; and the double cross-hatch bars are for variables for which MDI's could not be calculated.

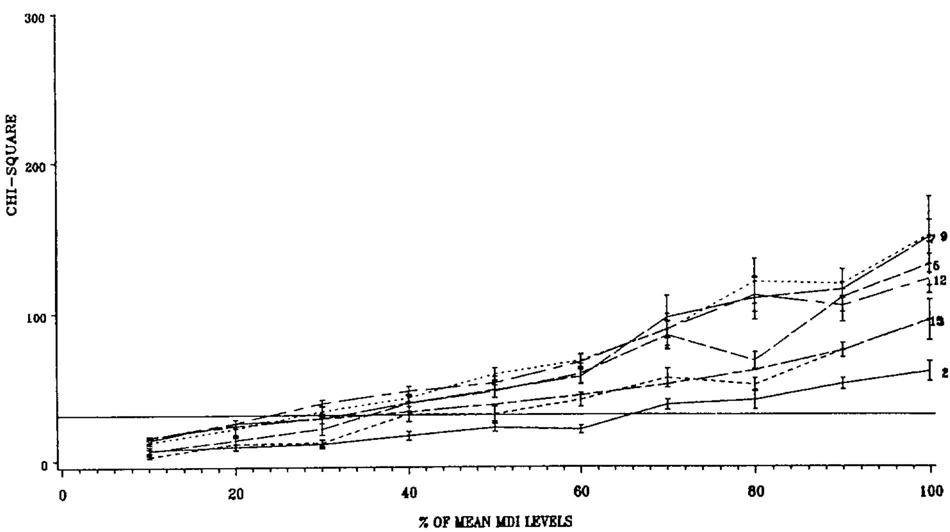

Figure 3. Chi-square versus percent of MDI's for sediment data employing multiple variable, single sample models. The values are means (plus and minus one standard error) of 10 replicate runs. The numbers to the right of the curves represent the number of variables (2, 3, 5, 7, 9, 12 15) impacted at the same time. The horizontal line is the chi-square criterion for p=0.01.

4 from the summer/fall set. Furthermore, the MDI's for these taxa represented reductions in abundance of more than 70% of mean values at the level of replication greater than or equal to that of the pre-operational survey.

Table 1."Red Flag" Values Produced from Multiple Variables MDI's Sediment Quality Data

Variable	Baseline Units	Means	Number of Variables Impacted at Once 1 (MDI)	2 (70% MDI's)	3 (50% MDI's)	5-15 (30% MDI's)
Cd	mg/kg	0.8	16	11	8	5
Cu	mg/kg	18	124	92	71	50
Pb	mg/kg	24	81	64	53	41
Hg	mg/kg	0.12	0.6	0.4	0.3	0.26
Zn	mg/kg	91	227	186	159	132
TKN	mg/kg	804	3,780	2,886	2,291	1,696
pH	-	7.6	6.0	6.5	6.8	7.1
OC	%	0.7	3.6	2.8	2.2	1.6
VS	%	2.8	*	93	68	42
# of taxa	-	28	22	24	25	26
#/m2	-	2,704	270	1,000	1,487	1,974
Biomass	g/m2	2.3	**	0.5	1.0	1.5
H	-	2.6	1.0	1.5	1.8	2.1
J	-	0.66	0.33	0.43	0.50	0.56
SR	-	3.1	2.5	2.7	2.8	2.9

Legend:
*= 100%
**=

It should be noted that when MDI assessments are performed, standard errors of the MDI's from multiple runs are calculated and the actual MDI levels are selected based upon the [β] level desired for the particular program. For example, a mean MDI would have a [β]=0.5, while a mean MDI plus one standard error would provide a probability of detection of 0.81 (assuming a t- distribution with d.f.=4). With the latter example, the investigator can be quite certain of being able to detect an impact of at least that magnitude. The balance between the probability of type II errors and the level of "detectable" change is determined by the investigator.

The results of the multiple variable spatiotemporal model for sediment quality data are presented in Figure 5. Spatiotemporal interaction models involving impacts on more than 3 variables required changes of only 40-60% of the univariate MDI's for statistical detection. In "real-world" perturbations, it is reasonable to expect that more than one variable would be impacted at the same time, so this model should provide the capability of detecting most changes at levels below those that may be considered to be ecologically significant.

A similar analysis on the benthic taxonomic data (46 dominant taxa) indicated that the absence (MDI = 100%) of more than 10 of the Summer/Fall taxa or 25-30 of the winter taxa would constitute statistically detectable impacts. Thus, the high degree of variability of the biological data reduces the focus of even the powerful MANOVA model to a question of the complete loss of fairly large numbers of taxa during post-operational cruises.

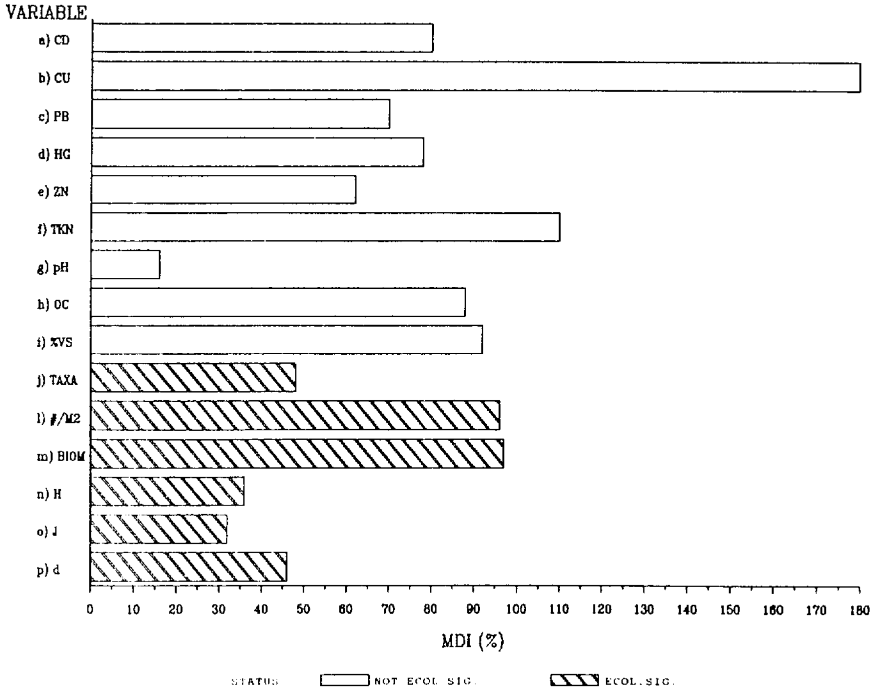

Figure 4. MDI's for sediment data employing spatiotemporal interaction models: the open bars are determined to represent levels of change that were not considered to be ecologically significant; and single cross-hatched bars are MDI's for which the level of change were considered to be ecologically significant.

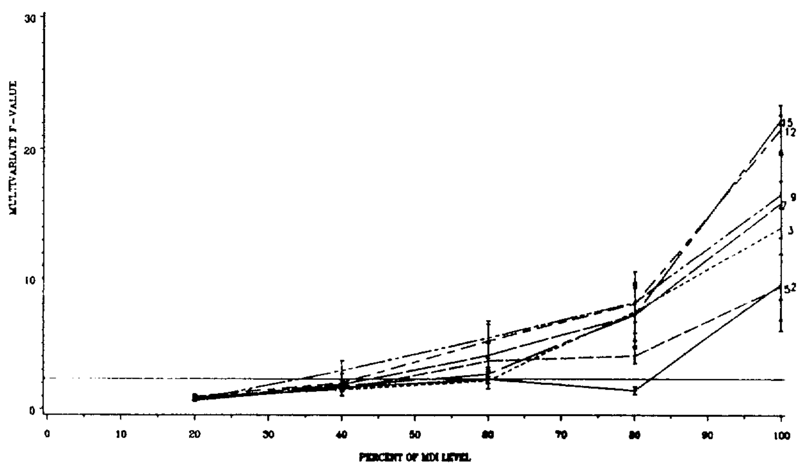

Figure 5. Mulitivariate F values versus percent of MDI's for sediment data employing multivariate spatiotemporal interaction models. The values are means (plus and minus one standard error) of 5 replicate runs. The number to the right of the curves represent the number of variables (2, 3, 5, 7, 9, 12, 15) impacted at the same time. The horizontal line is the F-value criterion for p=0.01.

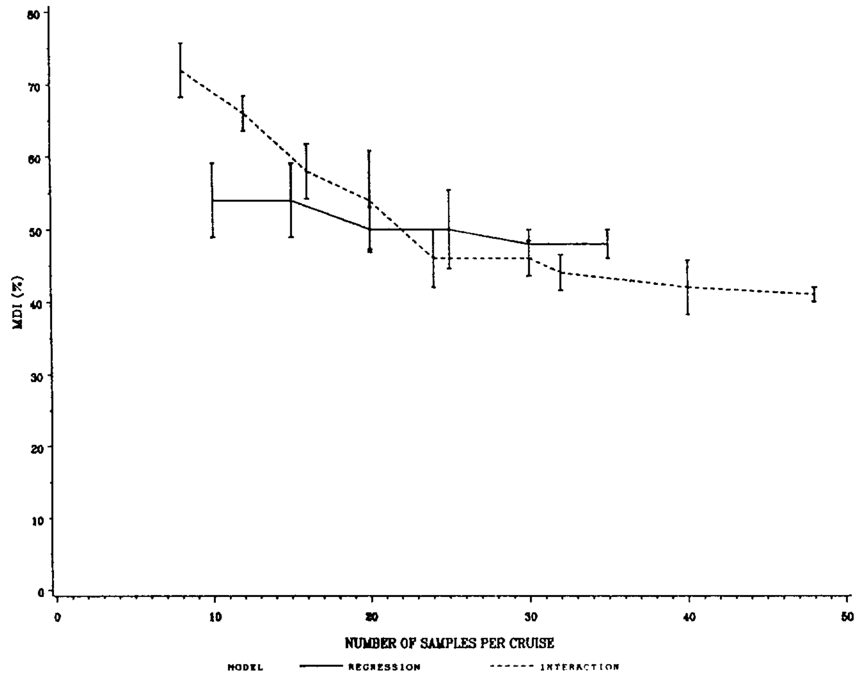

Figure 6. MDI's for sediment data employing nonlinear regression models: the open bars represent values which are equivalent to spatiotemporal MDI's; the single cross-hatch bars are MDI values for which the interaction model is more powerful; and the double cross-hatch is for the MDI for which the regression model is the more powerful model.

Nonlinear regression model

The results of the nonlinear regression model on the sediment quality data are presented in Figure 6. The histogram bars represent mean MDI's of 5 runs. The nonlinear regression model produced MDI's that were equal to those from spatiotemporal model for approximately half of the variables (open bars). The spatiotemporal interaction model produced lower average MDI's for the majority of the remaining variables. The analysis of most data sets produced the same trend: equal power of both models for approximately half of the variables; with the spatiotemporal interaction model displaying greater power in approximately 2/3 of the remaining variables.

The MDI assessment process can produce information which can be used to select an optimum sampling regime. If MDI's are plotted against sample numbers, the relative effects of adding replicates to the collection regime may be evaluated. For the spatiotemporal interaction model, there generally appears to be a decline in MDI's with increase in sample numbers up to a "breakpoint", beyond which the addition of samples does little to increase the power of the test. However, the nonlinear regression models seldom displayed such relationships with sample number. Increasing numbers of replicates did little to increase the power of the regression

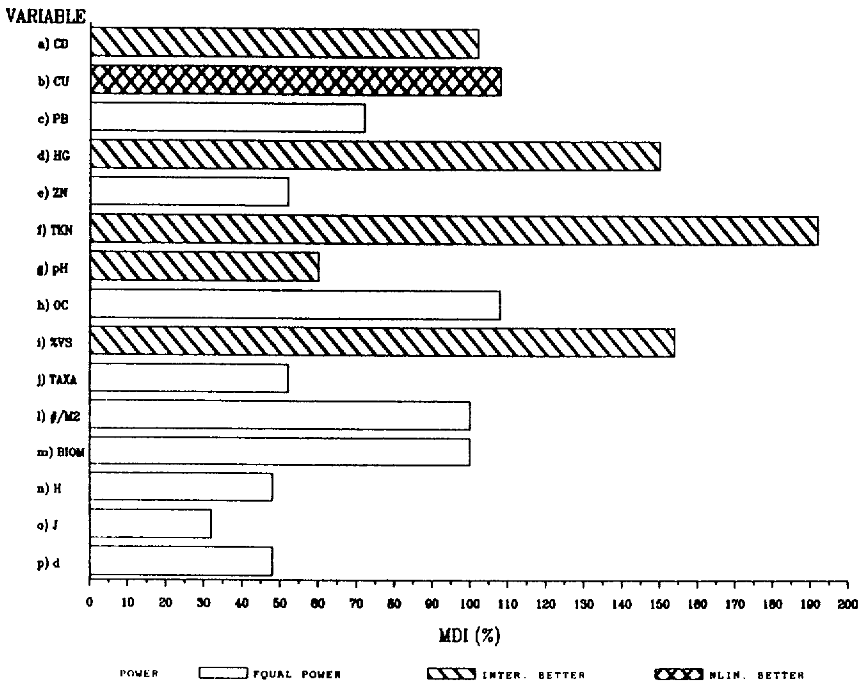

Figure 7. MDI's versus sample number for nonlinear regression (solid lines) and spatiotemporal interaction models (dotted line). The values are means (plus and minus one standard error) of 5 replicate runs.

tests for most of the variables. Figure 7 displays an example of these relationships.

It is obvious that the two models are approximately equal in power for the level of replication (20-24 samples per cruise) used in the pre-operational study. However, if only 10 or 15 samples had been taken, the regression model would have provided greater power than the spatiotemporal model. Thus, even though the spatiotemporal interaction model tended to produce somewhat lower MDI's for some of the variables under the pre-operational sampling regime, the regression model may prove useful if fewer samples were to be taken in post-operational cruises.

Robustness of interaction and nonlinear models

The evaluation of the robustness of the spatiotemporal MANOVA interaction model involved 250 tests of data sets randomly selected from the pre-operational sediment quality data. The observed α values from these tests corresponded very closely to the nominal α values. A regression of the observed α versus the nominal α values indicated a close fit (R^2=0.997), with nearly a 1:1 correspondence: observed α=0.01 + (1.002 x nominal α). Thus, the fact that the data were probably non-normal did not appear to affect the robust MANOVA model.

The evaluation of the nonlinear regression models involved 1,000 runs of the models on bootstrap simulations. The observed α versus nominal α curves indicated that this model was also very robust. In fact, 95% of the evaluations of sediment data indicated conservative tests (i.e. the probability of "false alarms" or Type I error being less than expected). None of the robustness evaluations indicated the problem of overly liberal tests (i.e. unexpectedly high Type I error).

Summary and Conclusions

Single sample MDI's varied in magnitude, but most would provide effective "red flags", especially when more than one variable is impacted at the same time. Although these "red flag" criterion are not designed to replace the more powerful statistical models, they do provide the opportunity for real-time response for QA/QC checks and/or for the implementation of contingency studies designed to investigate the magnitude and potential causes of apparent impacts.

The MDI's produced by the spatiotemporal interaction model were generally below levels considered to represent ecologically significant impacts, particularly when more than one variable was affected at the same time. The benthic taxonomic data were the exception. These biological data sets were so variable that MDI's could be determined for only a few taxa and complete absence of numerous taxa in the same cruise would be required for a statistically significant impact to be observed.

The nonlinear regression model and the spatiotemporal model produced equivalent MDI's for half of the variables tested. For the remaining variables, the nonlinear model produced somewhat higher MDI's in about 2/3 of the cases. However, the relationships between the MDI's and sample number differed between the two models. For the spatio-temporal model, MDI's declined significantly with increasing sample numbers up to a "breakpoint", which generally occurred at 10-12 replicates per zone. The MDI's from the nonlinear model displayed little relationship to sample number. Therefore, optimal numbers of samples may be decreased with the nonlinear model, if the investigator is willing to sacrifice a little sensitivity over that achieved by the spatiotemporal model at the breakpoint.

The MANOVA interaction model and the nonlinear regression models appeared to be quite robust. Despite the fact that the environmental data were nonnormal, the observed α values were equal to the nominal values for the MANOVA model and all of the nonlinear regression models were quite conservative (i.e. displayed a lower than expected probability for "false alarms"). Thus, the statistical models appeared to be both powerful and robust.

Many of the management implications of the MDI evaluations are obvious. The process can inform investigators and managers as to whether sampling regimes and statistical models have sufficient sensitivity for the desired purposes. It allows inspection of the minimum level of change in any given variable that can realistically be detected, regardless of the sampling effort. The optimal sampling regime can be designed to achieve sensitivity at the minimal amount of sampling effort. Furthermore, information is available to allowdecisions to be made concerning reallocation of resources within the program. Variables that provide little probability of impact detection (short of extreme perturbations) may be abandoned to free resources for greater focus on variables that provide good sensitivity. Such decisions can now be made in an informed manner.

References

Box. G.E.P. and D.R. Cox. 1964. An analysis of transfomations. J. Royal Stat. Soc. B. 26: 211-262.

Crisp, D.J. 1971. Energy flow measurements. In: *Methods for the Study of Marine Benthos*, Holmes, N.A. and A.D. McIntyre, eds. Handbook No. 16, Blackwell Scientific Publications, Oxford and Edinburgh,,pp. 197-279.

Diaconis, P. and B. Efron. 1983. Computer intensive methods in statistics. Sci. Amer. 248(5): 116-13.

Folk, R.L. 1974. *Petrology of Sedimentary Rocks*, Hemphill, Austin, 182 pp.

Green, R.H. 1979. *Sampling Design and Statistical Methods for Environmental Biologists*, John Wiley & Sons, New York, 257 pp.

Hampton Roads Sanitation District. 1984. *Environmental Assessment in the Vicinity of the Nansemond Treatment Plant Outfall - Vol. 1: Evaluation of Pre-operational Conditions*, Hampton Roads Sanitation District, Virginia Beach, VA, 36 pp.

Sediment Toxicant Evaluation in Harbors and Ports of the Northern Gulf of Mexico

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ABSTRACT

The Mississippi Sound mimics many of the characteristics of other estuarine systems along the North Central Gulf of Mexico. Commercial development with its associated pollution has been most intense in the the eastern sector, along the Pascagoula River and Bayou Casotte. A succession of ports and harbors in the Sound adds to the concern for pollution. An examination of sediments from 89 sites throughout the Sound has produced evidence of pronounced pollutant levels adjacent to industrial and municipal development with little evidence of effective transport of pollutants very far from their source. A sediment contaminant assessment, termed environmental stress index (ESI), that incorporates all pertinent environmental conditions has been applied to all ports, harbors and other regions of the Sound. Designed for easy use and interpretation, it can be used by developers for helping to ensure protection of sensitive estuarine environments. A port and a harbor was examined to show ease of use and interpretation using the ESI. The Port of Pascagoula has docking facilities that are maintenance dredged. Sediments in this port have lower concentrations of toxic pollutants than the undredged adjacent sediments. However, the ESI clearly shows that some of the environmental characteristics deteriorated as a result of dredging. Sediments from a small, city harbor having very high concentrations of toxic materials were flushed into the Sound as a result of a hurricane. Initially pollutant levels increased significantly in less than a year as the sediments were flushed back into the harbor. Modifications of the ESI during this period demonstrate the flexibility of this contaminant assessment tool.

INTRODUCTION

Mississippi Sound is an elongated, shallow embayment consisting of a series of small bays, marshes, bayous and rivers. The Sound is part of a region in the North Central Gulf of Mexico known as the "fertile fisheries crescent" because of its vast fisheries resources. A broad spectrum of users, including manufacturing and residential interests, has provided a needed boost to the economy of Mississippi, but is thought to be causing serious damage to this valuable fisheries nursery area. This small body of water shares many of the pollution problems with other estuaries along the Gulf of Mexico.

With continued pressure for expansion and rejuvenation of ports and harbors, there is concern for dredging, landfilling and other activities associated with these "links to the water". Though the two coastal ports of Mississippi are relatively small, the State Port at Gulfport and the Jackson County Port at Pascagoula are currently making preparations for upgrading their facilities, and there is apprehension for the impact of enlarged port operations on the biological community of the Sound. Many of the harbors serving the small communities along the northern perimeter of the Sound are also creating pollution concerns. Some like that at Ocean Springs act as recreational boating sites and as dumping sites for sewage that is often not adequately treated. The state of pollution in Mississippi coastal waters was essentially unknown prior to 1979. A four-year research project was begun in 1979 with a three fold objective: (1) determine levels and distributions of pollutants in the Sound, (2) generate a conceptual model of transport of pollutants, and (3) formulate a framework of scientific information to use in helping make sound decisions of development in this estuarine environment. In the scheme of this research an in-depth examination was made of one port and one harbor in Mississippi.

EXPERIMENTAL SECTION

Sample collection and analyses. Research efforts in all studies were concentrated on sediments rather than water or organisms due to the tenacity of sediments for most pollutants (Hunter *et al.*, 1979; Lee *et al.*, 1978; Jungclaus, Lopez-Avila and Hites, 1978; Oliver, Cosgrove and Carey, 1979) and because sediments document an integrated or "averaged" record of pollution incidents in the overlying water column. Industrial and municipal discharges, proximity to oil and oil-related industries and previous spot checks of pollution suggested emphasis on organic pollutants, specifically hydrocarbons, rather than other classes of pollutants.

Details of collection and analysis of sediments can be found elsewhere (Lytle and Lytle, 1985). A brief description follows. Hydrocarbon extraction and separations were made on sediments by use of solvent extraction, separation into aliphatic and aromatic fractions and analysis on a Perkin-Elmer (PE) Sigma 1 gas chromatograph coupled with a PE Sigma 10 data system. Additional information on polynuclear aromatic hydrocarbons was obtained through fluorescence using a PE MPF-44 fluorescence spectrophotometer and gas chromatography-mass spectrometry (GC/MS) through the Department of Chemistry, University of Alabama, Birmingham using a Hewlett Packard 5985 GC/MS computerized system. Phenol levels were determined by colorimetric procedures (USEPA, 1977). Total organic carbon (TOC) levels in sediments were measured by combusting samples in a LECO induction furnace and measuring the evolved CO2 volumetrically. The total Kjeldahl nitrogen (TKN) values were determined by a micro-Kjeldahl procedure (OMAOAC, 1975).

Environmental stress index. The concentration levels of various pollutants are important measurements, but these numbers mean little unless we can predict what harm they might have. We have combined a number of factors that we think are critical to assess the impact of polluted sediments and have called this system an Environmentral Stress Index (ESI). This system is designed to examine the most important scientific issues surrounding "pollution" for the Mississippi Sound. The system we feel provides the proper blend of chemical information with biological, geological and physical data to assess estuarine pollution. Chapman and Long (1983), Long and Chapman (1985), Chapman (1986) and Chapman et al. (1987) have urged the use of a similar indexing system in assessing sediment pollutants in Puget Sound, Washington and have termed their system the "sediment quality triad." The questions that were posed and were addressed individually by the present ESI system are: 1. How likely are organisms to be exposed to the toxic substances in the sediments. (disturbance probability) "How does the diversity of animal communities along the coast affect the risk or harm of polluted sediments." (biota susceptibility), "How toxic are polluted sediments," (toxicity) and "How long can organisms be affected by these sediments if they are disturbed," (suspension stability). The ESI uses a numerical rating as an answer to each question achieved in as objective a manner as possible which we feel provides a "user-friendly" means of assimilating very complex and sometimes confusing arrays of data. The first two criteria, disturbance probability and biota susceptibility, were not measured in laboratory experiments but through two panels of experts, which are described as follows.

Disturbance probability. Since the greatest impact by sediment pollutants would occur during a sediment disturbance, it is important to know the likelihood of a disburbance. A panel of experts was chosen whose knowledge and field experience would permit them to assess all factors affecting the likelihood of a disturbance. This team was composed of William Demoran and James Warren of the Gulf Coast Research Laboratory (GCRL), Ocean Springs, MS, and Ron Herring, Tom VanDevender and Chris Snyder from the Mississippi Bureau of Marine Resources. Considerations used for the evaluation were: water depth, density of boat traffic, dredging activity, tidal force, fish trawling, river flow turbulence, and benthic community composition. Each panelist gave a rating of 1 to 5 (5 signifying the greatest likelihood of frequent and/or serious sediment disturbances) in each category to each of the 34 study sites. The average rating among the panelists was the single number describing the disturbance probability at each site.

Biota susceptibility. An effort was made to provide a rating system to express the innate differences in the stress susceptibility or vulnerability of the organism community structure that resides or would be attracted to each of the 34 zones. A panel of three fisheries biologists from GCRL, Richard Waller, Harriet Perry and William Demoran, was enlisted to evaluate this factor. The criteria used in the evaluating decisions were: the ecological significance of resident organisms, the mobility of these organisms, presence of "escape" routes in the vicinity, the predominance of early life stages of organisms which are usually more vulnerable to chemical toxicants, diversity of the community and the knowledge of the sensitivities of the various organisms to stress events in the environment. Again a rating of 1 to 5 was given, with 5 indicating the most sensitive assemblage of animals. A single rating was achieved by averaging the various ratings of the panelists.

Toxicity. Ratings of toxicity and suspension stability were made through laboratory tests. Samples collected at 34 surface sediment sites, designated in Fig. 1 with a 2-letter code, were subjected to toxicological bioassays designed to give some predictive measure of the biological impact of disturbing these sediments. The bioassay procedures used were those developed by a joint effort of the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers to examine possible impact following a pronounced sediment disturbance (Dexter and Pavlou, 1978; Dunn and Fee, 1977; and Hunter *et al.*, 1979). These tests were run in three phases. A filtered liquid phase was used to evaluate the impact of dissolved chemical constituents released from the sediment during a sediment disturbance. A particulate phase measured the impact due to both the presence of suspended particles and any toxic components desorbed from the particles. A solid phase evaluated the biological effect of the sediment that settles after a disturbance.

Test organisms were exposed to preparations made as follows: liquid phase—a 0.45μ filtrate from sediment mixed with site water (1:4, V/V); particulate phase—using unfiltered sediment- water mixture (1:4, V/V); and solid phase—using the sediment settling from the particulate phase preparation with a fresh portion of site water.

The first two phases were designed to test free-swimming organisms. Organisms chosen were mysid shrimp (*Mysidopsis almyra*) and sheepshead minnows (*Cyprinodon variegatus*). In the solid phase, bottom feeders, mysid shrimp, and an amphipod (*Gammarus mucronatus*) were tested. Mortalities were determined at 24-hour intervals for 96 hours in the liquid and particulate phases, and only at the end of 96 hours in the solid phase test. Filtered collection site water and seawater were used as control media against which to assess significance of mortality data (Lee *et al.*, 1978). If mortalities were significant they were then given a rating of 1-5, with a 5 indicating 80-100% mortality during the progression of the bioassay.

Suspension stability. To investigate the overall impact of resuspension of contaminated sediments, settling rate characteristics were determined. The ratio of 1:4, V/V sediment and water, were used as prescribed in the toxicological testing. Approximately 250 g of sediment were dispersed in the appropriate amount of site water in 1 gallon jars using a platform shaker for dispersal. At the end of a 5-minute shaking period, 1 minute elapsed before an initial 5-ml sample was withdrawn from 2 cm beneath the surface. Additional aliquots were withdrawn for 3 days and analyzed gravimetrically for suspended solids. Curves were constructed of total suspended solids *vs* elapsed time to describe graphically the settling rate behaviors. Three numbers were taken from these charts to reduce the settling rate curves to a numerical rating. The initial suspended solids and the times for these loads to drop to 1/2 and 1/4 of the initial level were each separately rated on a 1 to 5 scale with an averaged value being then fed into the ESI system.

RESULTS AND DISCUSSION

Organic pollutants in surface sediments. Detailed surveys of sediment pollutant levels and results of tracer studies of pollutant migration in the Sound are available in published form (Lytle and Lytle, 1985; Lytle and Lytle, 1987). For simplicity this data has been summarized for the following zones: Pascagoula River (all sites in East and West Pascagoula River, Escatawpa River and Bayou Casotte, where greatest abundance of industrial development has taken place), Biloxi Bay (with a moderate degree of industrialization), St. Louis Bay (Heron Bay and St. Louis Bay) with little industrial development), Mississippi Sound (open Mississippi Sound), and Gulf of Mexico (site beyond the offshore islands). TOC values and other chemical variables for these regions are shown in Table 1. TOC is subject to considerable natural variability and only when values greatly exceed 'norm' values can TOC be used as a positive indicator of pollution in sediments. The overall highest TOC values are seen in the Pascagoula River with values in Biloxi Bay dropping considerably and those of St. Louis Bay declining to levels only slightly higher than the Sound and Gulf samples. Using TOC as a gross indicator of pollution, the strongest evidence of pollution exists for discrete sample sites along the Pascagoula River with some sites in Biloxi Bay also showing unusually high TOC.

Ranges of TKN values are less dramatic than TOC values though location of highs and lows are similar for the two variables. There are higher values in the bays and rivers compared to the Sound and Gulf with isolated highs near municipal sewage discharges as expected. The Pascagoula River region, as with TOC, has the highest mean value of TKN, the largest variation and largest range of values.

Total phenol values show a somewhat different distribution than either TOC or TKN. The Pascagoula River still dominates in high values but only slightly. It is noteworthy that phenols occur at levels reported here in view of the ease of oxidation of phenols to quinones (Anderson 1979).

The most profound story may be told, however, for hydrocarbons in Table 1. The Pascagoula River leads in overall levels with a mean value of 1800 μg/g (ppm) and values at discrete locations ranging as high as 13,000 ppm. Not far behind the Pascagoula River is Biloxi Bay with a mean of nearly 700 ppm and individual stations showing hydrocarbon levels in the 8,000 ppm range. Both regions contain sites with serious hydrocarbon pollutant levels. St. Louis Bay is only modestly more elevated in sedimentary hydrocarbons than the Sound and Gulf samples with much lower levels than Biloxi Bay or Pascagoula River. A sharp distinction can be made between the bays/rivers and Sound/Gulf areas particularly at the eastern end of the Sound in the levels of hydrocarbons measured in each region. This same distinction can be made when looking at the aromatic hydrocarbons in Table 1. There is no real difference in aromatic hydrocarbon values between the Pascagoula River and Biloxi Bay which average 30 times the mean values in St. Louis Bay and 60 times those observed in the Sound and Gulf regions. It can be said with strong confidence that there are hydrocarbon pollution problems in the Sound; the real problem areas are not in the open Sound area but in the bays and rivers on the perimeter especially at the central and eastern portions.

Environmental stress index. Various proposed land uses will be predicated upon environmental considerations that will differ markedly. Since each of the factors composing the ESI system invoke different environmental variables, the best use of the ESI system comes through examination of the rating in each separate category for a given geographic region as well as the chemical pollutant level data. However those responsible for making informed decisions about land-uses in the coastal zone are often not well versed in the interpretation of scientific data even that as simplified as the four rated categories of the ESI. A further simplification can be achieved by taking the mathematical product of the four rated factors in the ESI. These products of all factors have been plotted in Fig. 2. Because no one sample site was ranked at a four or five in all four categories, no area would be ranked as a catastrophic area, but Fig. 2 does emphasize some "hot spots" that warrant concern, specifically Pogey Plant (PP) in the Escatawpa River, Lake Yazoo (LY) at the mouth of the East Pascagoula River and Gulfport Lake (8/GL) in the Industrial Seaway of Bernard Bayou of western Biloxi Bay. Sites with an intermediate danger signal are: Escatawpa River Bridge (ER), Mary Walker Bayou (24/MW), Cooling Tower Canal (CT), Rhodes Point (RP) and Deer Island (4/DI). Sediments from the Pascagoula River pose more concern than those in other broad regions of the Sound with less concern for sediments taken further offshore or at the western end of the Sound. It is suggested that one use the ESI product to identify potential problem areas and then follow this intial examination by careful scrutiny of the individual factors to see where potential problems may arise.

Maintenance dredged ports. One area that received intensive study was that of Bayou Casotte, which is the primary docking area of the Port of Pascagoula (Lytle and Lytle, 1983). This area provided an opportunity to evaluate the impact of maintenance dreding on sediment quality. The lower half of this bayou sampled at Chevron N. Dock (CD) and Mississippi Chemical East Bank (MC) (see Fig. 1) is routinely dredged, whereas the upper bayou represented by Cooling Tower Canal (CT) and West Prong (WP) sites is not, so that a "before" and "after" scenario is possible in one sampling effort. Only slightly lower ESI values shown in Fig. 2 for the dredged area compared to the undredged upper reaches of the bayou might be puzzling considering that levels of pollutant hydrocarbons in the undredged sediments are >100 times those in the dredged sediments, and also demonstrated much higher toxicities. Though dredging has removed much of the surface sediment contaminants in the lower part of the bayou, greatly increased boating activity has increased the likelihood of sediment disturbance (disturbance probability). Furthermore the sediments that were exposed by the dredging operations are very rich in fine-grained material leading to enhanced stability of sediment suspensions (suspension stability). Therefore the positive effects of toxic sediment removal have been somewhat offset by worsening other environmental factors. Decisions concerning dredging in harbors obviously is much more complicated environmentally than choosing dredging and disposal methodology.

Effects of storms in harbors. The values of the ESI factors can change as conditions in any area change. One area of the Sound provided an opportunity to study just how these factors can change as human impact in the environment changes. January, 1986 was set as the date for abatement of treated sewage discharge into Ocean Springs Harbor (just east of site DB,1 in Fig 1). A study was designed to see how quickly the sediments that were impacted by this discharge could show the benefits of sewage abatement. However soon after pre-abatement samples were taken, a category 3 hurricane came ashore at this site on Labor Day, 1985. East to west movement of the storm center over the harbor caused both strong negative and positive tidal surge action. The focus of the study was broadened to include an examination of surface sediments after a major storm in a coastal inlet.

Results of hydrocarbon analysis from the pre-abatement and two post-hurricane samplings are shown in Table 2. Hydrocarbon levels in sediments, both aliphatic and aromatic, are very high at all sites but station 5 before the hurricane but particularly so at station 1 nearest the sewage outfall. Elevated concentrations of hydrocarbons as a result of sewage discharge is not surprising since sewage is a leading source of environmental contamination by hydrocarbons (Farrington and Quinn, 1973; Van Vleet and Quinn, 1977; Leland, Luoma and Elder, 1978). Hydrocarbon levels measured on November 15, 1985, two months after the hurricane, showed drops of 75% in hydrocarbon loads compared to pre-hurricane levels. Apparently, much of the fine- grain sediments holding most of these pollutants were flushed out of the bayou due to hurricane action. Seven months after the hurricane, sedimentary hydrocarbon levels had begun to rise, almost doubling the quantities of pollutant hydrocarbons at all five sites found two months post-hurricane. It is suggested that the fine-grained materials that had been washed out of the harbor by storm action are beginning to be transported back into the harbor. The effects, positive or negative, of storms may be quite temporary in the translocation of polluted sediments. The likelihood of such disturbance events obviously does play an important, albeit short-lived role in the mobilization of polluted sediments in and around ports and harbors and must be considered in environmental impact studies. The ESI system can be readily modified as such natural and unnatural events occur in any region. Hopefully, the index system will provide a mechanism that can be easily assimilated to help developers as well as those interested in preserving the environment make wise decisions. Decisions concerning key economic and environmental issues such as dredging, placement of industrial parks, real estate developments and recreational centers can benefit from a system designed to promote a more informed and rational understanding of sediment pollution impact for industry, coastal zone managers and the public.

ACKNOWLEDGMENTS

This work resulted primarily from a four-year research project sponsored by NOAA, Office of Sea Grant, U.S. Department of Commerce, under Grant Numbers NA79AA-D-00049, NA80AA-D-00017 and NA81AA-D-00050, project No. R/ER-2 and by the Gulf Coast Research Laboratory, the Mississippi-Alabama Sea Grant Consortium and the State of Mississippi.

REFERENCES

Anderson, J.W., *Marine Pollution: Functional Responses*, Vernberg, W.B., F.P. Thrunberg, A. Calabrese and F.J. Vernberg, editors. Academic Press, NY, p. 3 (1979)

Chapman, P.M., *Environmental Toxicology and Chemistry, 5* 957 (1986).

Chapman, P.M. R.C. Barrick, J.M. Neff and R.C.Swartz, *Environmental Toxicology and Chemistry, 6* 723 (1987).

Chapman, P.M. and E.R. Long, *Marine Pollution Bulletin, 14* 81 (1983).

Dexter, R.N. and S.P. Pavlou, *Marine Chemistry, 7* 67 (1978).

Dunn, B.P. and J. Fee, *Journal of Fisheries Research Board of Canada, 36* 1469 (1979).

Farrington, J.W. and J.G. Quinn, *Estuarine and Coastal Marine Science, 1* 71 (1973).

Hunter, J.V., T. Sabatino, R. Gomperts and M.J. Mackenzie, *Journal of Water Pollution Control Federation, 51* 2129 (1979).

Jungclaus, G.A., V. Lopez-Avila and R.A. Hites, *Environmental Science and Technology, 12* 88 (1978).

Lee, R.F. W.S. Gardner, J.W. Anderson, J.W. Blaylock and J.B. Clark, *Environmental Science and Technology, 12* 832 (1978).

Leland, H.V., S.N. Luoma and J.F. Elder, *Journal of the Water Pollution Control Federation, 6* 1469 (1978).

Long E.R. and P.M. Chapman, *Marine Pollution Bulletin, 16* 405 (1985).

Lytle, J.S. and T.F. Lytle, *1983 Proceedings of Oil Sill Conference,* American Petroleum Institute, Environmental Protection Agency and U.S. Coast Guard, San Antonio, TX, p. 491 (1983).

Lytle, T.F. and J.S. Lytle, *Pollutant Transport in Mississippi Sound,* Mississippi-Alabama Sea Grant Consortium, Sea Grant Publ. No.: MASGP-82-038 (1985).

Lytle, T.F. and J.S. Lytle, *Chemosphere, 16* 171 (1987).

Official Methods of the Association of Official Analytical Chemists. 1975. *In* W. Horwitz (ed.). *Association Official Analytical Chemists,* Washington, D.C. 927 p.

Oliver, B.G., E.G. Cosgrove and J.H. Carey, *Environmental Science and Technology, 13* 1075 (1979).

U.S. Environmental Protection Agency, *Interim methods for the sampling and analysis of priority pollutants in sediments and fish tissue.* Cincinnati, OH (1977).

Van Vleet, E.S. and J.G. Quinn, *Environmental Science and Technology, 11* 1086 (1977).

Table 1. Pollutant variables in Mississippi Sound surface sediments[a]

Location	TOC (%)	TKN (mg/g)	Phenols (fg/g)	Total HC (fg/g)	Aromatic HC (fg/g)
Pascagoula River (26 samples)	4.05 + 3.98 0.145-14.0	1.43 ± 1.21 n.d.-4.24	1.04 ± 0.727 n.d.-2.75	1,800 ± 3,520 0.20- 13,300	L211 ± 432 n.d.-1,930
Biloxi Bay (19 samples)	1.76 ± 0.832 0.315-3.67	0.88 ± 0.616 0.07-2.59	0.604 ± 0.510 0.254-2.39	686 ± 1,97 1.15- 8,600	186 ± 595 0.410-2,610
St. Louis Bay (4 samples)	1.45 ± 0.777 0.328-2.08	1.19 ± 0.200 0.97-1.39	0.543 ± 0.167 0.378-0.773	36.6 ± 21.0 12.8-63.9	7.37 ± 2.82 3.52-9.77
Mississippi Sound (15 samples)	0.869 ± 0.420 0.096-1.36	0.568 ± 0.505 0.0045-1.55	0.647 ± 0.493 0.224-1.77	16.8 ± 12.2 0.986- 69.9	3.07 ± 2.96 0.070-11.0
Gulf of Mexico (1 sample)	1.09	0.73	0.285	18.9	3.77

[a]Total organic carbon, total Kjeldahl nitrogen, phenols, total hydrocarbons and aromatic hydrocarbons. Reported values are means ± one standard deviation/minimum-maximum values. N.d. = not detected and entered as 0.0 in mean calculations.

Table 2. Sedimentary hydrocarbons in Ocean Springs Harbor[a]

Station[b]	March 20, 1985 aliph.	March 20, 1985 arom.	November 15, 1985 aliph.	November 15, 1985 arom.	April 25, 1986 aliph.	April 25, 1986 arom.
1	3150	1530	587	214	754	279
2	1080	367	42.0	15.5	215	61.4
3	1440	401	328	95.7	560	133
4	1000	359	265	130	541	180
5	95.5	47.8	14.8	6.27	50.6	25.8

[a]Ocean Springs Harbor is the small inlet just east of station DB,1 in Figure 1. Surface sediments were collected in March, 1985, seven months before sewage abatement was to occur; samples in November, 1985 and April, 1986 were collected two and seven months respectively after passage of a major hurricane over the harbor. All concentrations are in μg/g dry weight of aliphatic and aromatic hydrocarbons.

[b]Station 1 is adjacent to sewage outfall, station 5 at mouth of harbor and stations 2,3 & 4 at sites intermediate sites.

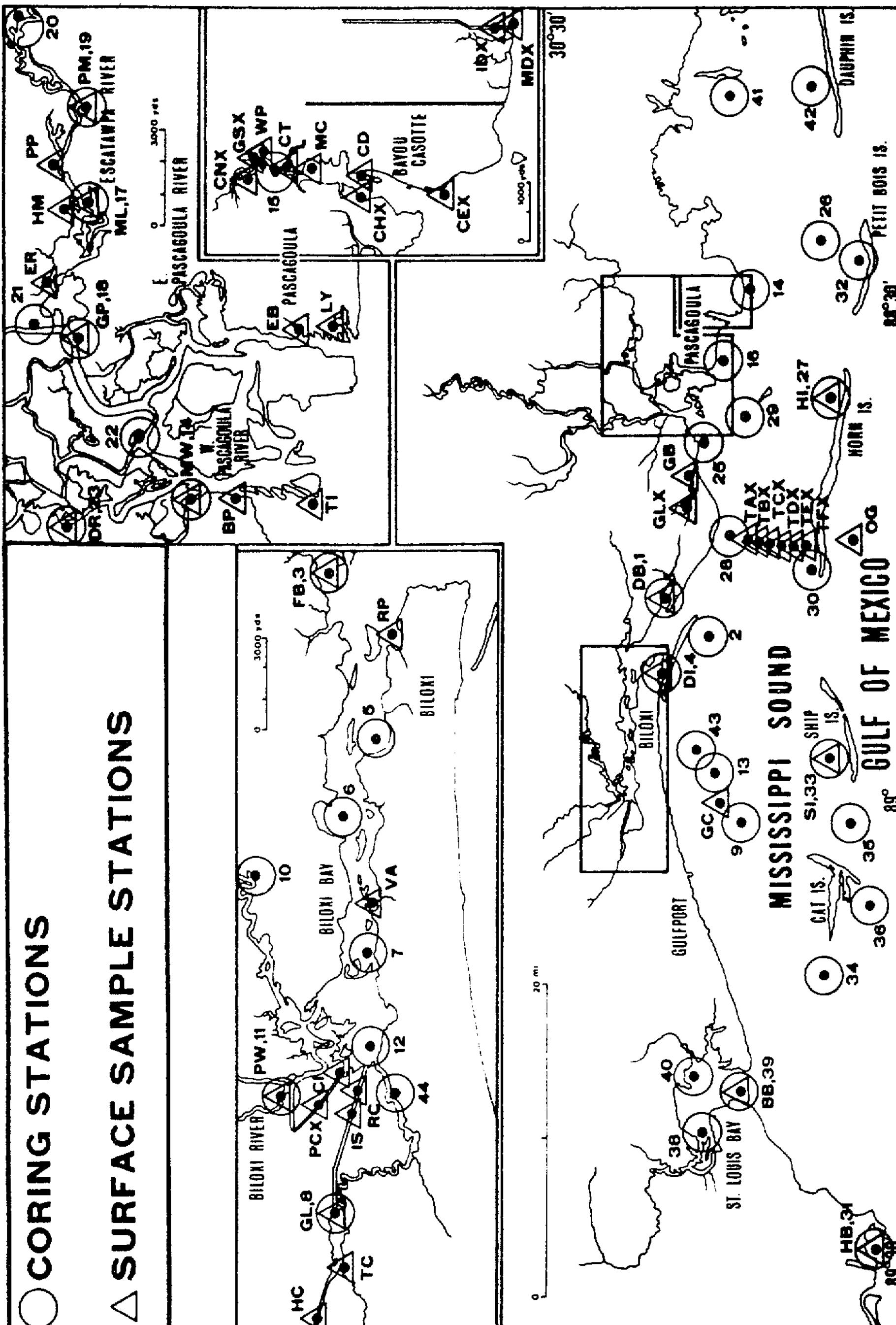

Figure 1. Sample site locations in Mississippi Sound. Number codes are for coring stations, with letter codes for surface sediment samples.

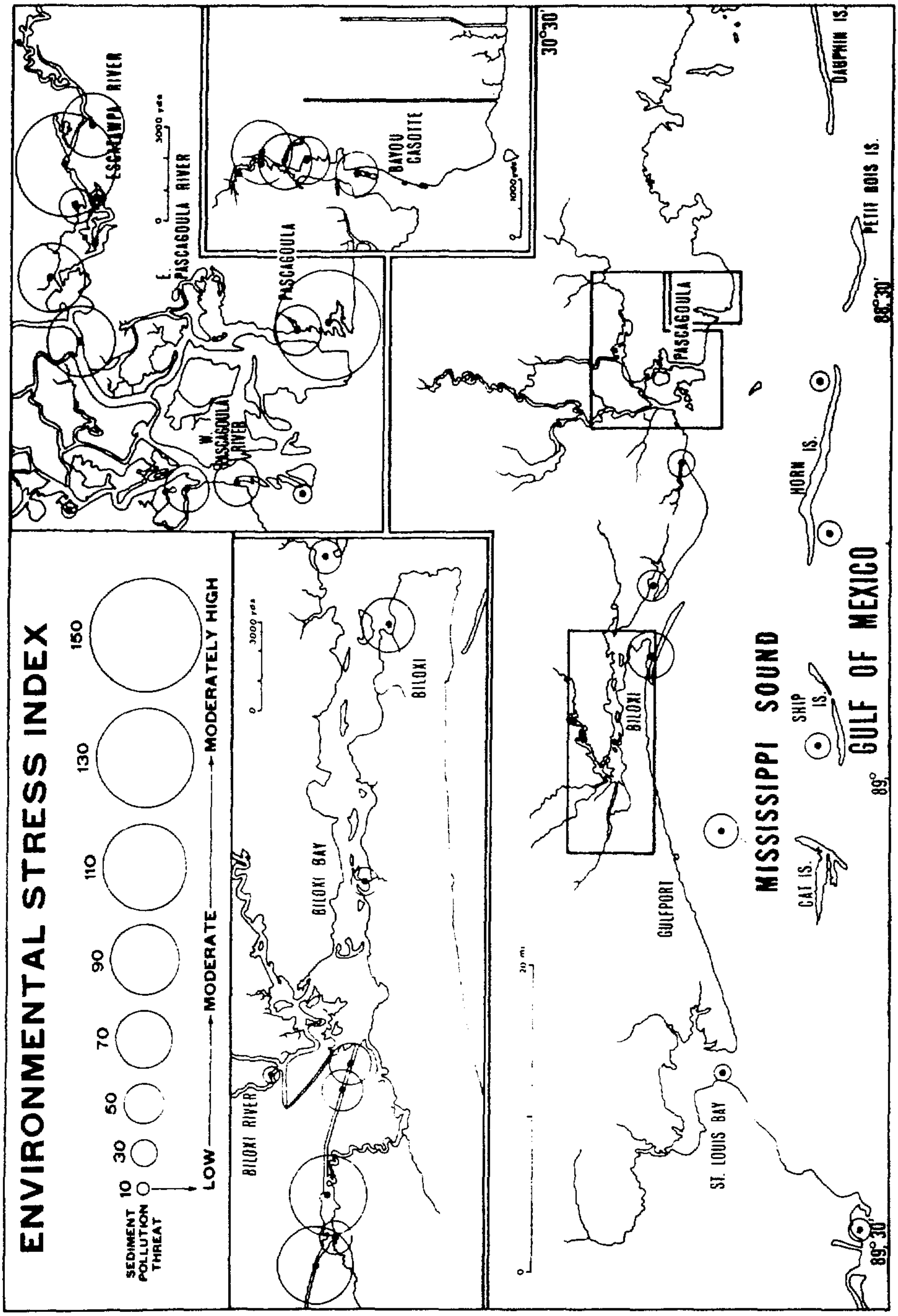

Figure 2. Environmental stress index for surface sediments of the Mississippi Sound. Circle diameters at each site are proportional to the product of all factors assimilated in the stress index including: toxicity, suspension stability, disturbance probability and biota susceptibility. Individual ratings may be found in Lytle and Lytle, 1985.

DREDGING AND DREDGED MATERIAL MANAGEMENT: THE NEED FOR A NEW NATIONAL POLICY

Statement of Brendan W. O'Malley
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Coastal Society Eleventh International Conference
Boston, Massachusetts
October 26, 1988

Good Morning. My name is Brendan O'Malley. I am the Assistant Director of the Port Department of The Port Authority of New York and New Jersey. Today, however, I speak to you not as a representative from one port, but as a member of the port industry, to discuss the national problem we all face—the dredging and disposal of dredged material required to keep waterborne commerce moving into and out of the United States.

All ports in this country, particularly estuary ports, need to dredge their navigation channels and berths to accommodate shipping. New York Harbor, for example, has a natural depth of 19 feet. Its main channel is dredged by U.S. Army, Corps of Engineers to a depth of 45 feet. The Port Authority of New York and New Jersey is presently the Local Cooperating Agency with the Corps to deepen New York's main general cargo channels, the Kill Van Kull and Newark Bay, to 40 feet. New York and New Jersey are not alone in the effort to provide the necessary navigation channel depths and access for cargo vessels coming into port. The Ports of Baltimore, Norfolk, Oakland, Los Angeles and Long Beach, to name a few, are all involved in similar deepening projects. Common problems we all share are the disposal of dredged material, its misperception on occasion by the public as a "toxic waste", and the loss of disposal sites due to environmental and/or developmental pressures.

During this past summer, the American Association of Port Authorities surveyed its membership concerning dredged material disposal practices. The survey, developed by the Harbors and Navigation Committee of the AAPA, was designed to give an overview of the dredging issues facing our nation's ports. They looked at the quantities of dredged material, the types and availability of disposal sites, and present and future environmental concerns. The survey, when finalized, will also include dredging information from the District Offices of the Army Corps of Engineers.

Although the survey results are not complete, I would like to share with you some of the survey's preliminary findings. The total annual quantity of dredged material for the forty four responding ports was 104 million cubic yards. Eighty three million cubic yards was Federal work and 21 million cubic yards was non-Federal work. The survey revealed that approximately 80 percent of all maintenance dredging work is Federal.

It is interesting to note that the highest maintenance volume for an individual port agency was five million cubic yards, while a few ports reported no maintenance volume. The largest Federal maintenance dredging was 35 million cubic yards, with the next highest value being 6 million cubic yards. Because the U.S. Army, Corps of Engineers is this nation's primary contracting agency for dredging construction and the agent for the Federal government for keeping open the channels so vital to the commerce of this nation, the ports believe the Corps should be mandated to have greater responsibility for resolving dredge disposal issues.

In regards to new construction, 60 percent of the responding ports to date had performed new construction within the last two years. Fifty-nine percent of the new construction was performed by the Federal government, amounting to a total of 62 million cubic yards of material. Non-Federal interests accounted for 43 million cubic yards. Thus, the total quantity of new construction for the past two years was 105 million cubic yards.

Eighty-two percent of the ports (Federal and non-Federal interests) will undergo channel dredging in the future for new construction projects. The schedule of construction spans 12 years. The new work is estimated to 212 million cubic yards of dredged material. In visual terms, that amount would fill 106 New York World Trade Center towers. One port plans the removal of 70 million cubic yards, and others are more modest at 28 million cubic yards and less. As you can see, many port agencies, in cooperation with the Corps of Engineers, are in the midst of or planning major dredging construction projects and, I might note, will be assuming significant financial responsibility for those projects as well.

The survey sought to determine where most dredged material is disposed. Ocean disposal, coastal waters, confined upland, containment islands and beneficial uses were the most common disposal options used. We found that 76 percent of the ports use either ocean and/or coastal water disposal, while 66 percent use confined upland. Some 32 percent use containment islands for disposal of dredged material. In addition, one quarter of all the ports are able to use some of their material for beneficial use, such as beach nourishment or wetland creation.

Although most ports use a mixture of disposal options, a few use a single disposal method. Four ports use solely confined upland, two ports use only the ocean and two use coastal waters for disposal. One port is able to use 100 percent of their material for beneficial uses.

The most critical finding was that 63 percent of the responding ports indicated that they will have difficulty in identifying new dredged material disposal areas. Of these, most stated the major obstacle in procuring new sites was environmental concerns and the lack of space due to increased development. The loss of a dredged material disposal area for new construction places a heavy economic burden on a port agency. In 1986, Congress passed the Water Resources Development Act which states that "the non- federal interests for a project (usually a port agency) shall provide....dredged material disposal areas necessary for the project."

Presently, the average costs for dredged material disposal, that includes dredging, transportation and disposal, ranged from \$0.90 to \$60.00 per cubic yard. Those ports who used confined upland disposal had the highest costs. Eighty-nine percent of the responding ports anticipate their costs will escalate seriously if they are forced to change their disposal practices.

A change in disposal practices with the concomitant increase in cost would cause a crisis for the national port system. As port authorities and the Corps of Engineers experience increased costs for dredged material disposal, those projects that have a 20 percent increased project cost must be reevaluated as to their economic cost/benefit ratio as provided in the cost sharing requirements of the Water Resources Development Act. It is conceivable that many dredging projects may not get constructed, thus diminishing a port's capability to handle larger ships and in turn affecting the competitive position of the United States in world markets.

So, to recap.....there is a need to dredge the nation's ports and navigational channels. From the AAPA survey, we find that maintenance dredging is ongoing and, indeed, that new work to deepen channels is expected to increase in the next few years. We found the bulk of the work to be Federal. There is a nationwide future need for dredged material disposal sites. The designation of these sites will be difficult, particularly in light of the nation's heightened sensitivity to environmental concerns and the increase in development near our coastal regions.

In response to the coming national dredged material disposal crisis, it is now time for all of us to work towards a new comprehensive national policy for dredge material management. The first step is for the Corps, in close cooperation with ports and states, to establish regional scientific criteria for dredged material. We all understand that our knowledge of contaminants changes, and criteria must be updated at regular intervals, but ports must have a reasonably consistent "guide" to follow in determining whether the material they dredge is contaminated or clean. The criteria used must include economics and be based on scientific facts with reasonable margins for safety, not on public hysteria encouraged by the media every time a "new" contaminant makes the limelight. Testing procedures for dredged material disposal permit compliance must be standardized throughout the country.

Equally important, a public education program must be developed. Ports need to assist in educating the public about the economic necessity of dredging and that 90 percent of dredged material is acceptable for water disposal. In response to that need in our area, and as a first step, The Port Authority of New York and New Jersey sponsored a conference on the Environmental and Economic Impacts of Ocean Disposal of Dredge Material, conducted by the New Jersey Marine Sciences Consortium. We invited scientists, persons from government, environmentalists, labor and members of the port industry. We did not resolve all our differences, but we found that the environmental community and the port industry have more in common than they thought, and the scientists were ready and able to explain their findings on dredged material management. We hope that the report from the Conference will be used as an education tool to convey a better understanding of the Port and its need to dredge.

The public's lack of hard information about dredged material allows them to be easily frightened—and increases the likelihood that dredged material will be lumped with sludge or toxic materials. The public, in turn, clamors for their legislators to "do something". As an example, the legislators form the New York-New Jersey area added a section to the Water Resources Development Act of 1986 that requires the Environmental Protection Agency to designate a new dredged material disposal site at least 20 miles from shore. This was a legislative remedy, in response community concerns, which arbitrarily limited the location for a new site rather than relying on scientific methods and environmental standards. Through education and active participation, all parties involved with the designation of a new disposal site must be as informed as possible to find economically and environmentally acceptable solutions.

We can't stop dredging if the ports are to continue to provide economic benefits to the nation. While we wait and debate nature will have its way, and the arteries of commerce on which our nation is vitally dependent will clog with the sediment which is inexorably carried to our ports. There can be no status quo. Therefore, the Federal government, including Congress, must involve itself in addressing the dredged material disposal site crisis that is developing. Dredging and the disposal of material is not merely a local issue but a national concern as the ports provide benefits and services to all Americans, whether they live on the seacoast or in middle America. We cannot lose sight of the fact that the Federal Congress' concern with the livelihood of its ports dates back to 1783 when the first levies on port commerce were enacted by the Continental Congress. The Congress at that time viewed ports as a national asset, enacted custom duties for their use and pledged to safeguard them. Since the very beginning of our republic the maintenance of navigable waterways has been, properly, a matter of national concern. We believe therefore, that the priority to maintain the ports and their channels is a full time commitment from the government, the ports, and public.

Thank you.

WETLANDS MITIGATION BANKING

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National recognition of the value of our wetland resources has never been greater than at the present. During his recent campaign, President-elect Bush established a goal for his Administration of "no net loss of wetlands." In 1986, the Environmental Protection Agency (EPA) formed the Office of Wetlands Protection which emphasized the Agency's commitment to protecting and restoring wetlands. In the Spring of 1987, EPA's Administrator asked the Conservation Foundation to convene and facilitate a national forum on wetlands issues. The National Wetlands Policy Forum, chaired by New Jersey Governor Thomas Kean, included members from a broad range of interests including: state and local governments; development; agriculture; forestry; environmental groups; and academic experts in wetland policy and science. EPA and four other key Federal agencies participated on the Forum as *ex officio* members. While the Forum recommended over 100 specific actions, several are directly related to wetlands mitigation, including mitigation banking. Specifically, the Forum recommended a goal of no overall net loss of the nations remaining wetland base, as defined by acreage and function; and to restore and create wetlands, where feasible, to increase the quality and quantity of the nation's wetlands resources. EPA supports the direction that the Forum recommendations have set and, within existing resource constraints, is incorporating them into Agency policies as well as its daily actions.

While the adoption of a "no net loss" policy is a significant milestone in the area of wetlands protection with specific implications for the development of a future national mitigation policy, the regulatory agencies realize that economic forces will not allow such a policy to bring all development in this country's wetlands to a halt. This potential conflict further emphasizes the need for a national mitigation policy since compensatory mitigation will, in most cases, be the only way that the regulatory agencies can approve unavoidable wetlands destruction. In light of the above, wetlands mitigation banking has the potential to be an important factor in meeting the desired goal of restoring and maintaining our wetland resources.

Prior to discussing mitigation banking it is important to have a basic understanding of EPA's position on mitigation in general. EPA has, for many years, consistently maintained the position that mitigation should occur in the sequence of avoidance first, then minimization and lastly compensation of unavoidable impacts. EPA considers these specific elements to represent the required sequence of steps in the mitigation planning process as it relates to the Section 404 program and adheres to the requirements set forth in the 404(b)(1) Guidelines. In this regard, EPA maintains a strong position against using compensatory mitigation in any form to reduce or "buy down" the environmental impacts of one alternative when another less damaging alternative exists. Equally as strong is the position that mitigation measures must be implemented in such a way as to prevent a net loss of 404 regulated wetlands. With this framework in mind, the balance of this paper will focus on a discussion of mitigation banking, a form of compensatory mitigation. At this time EPA does not have a formal policy on mitigation banking. In this regard, the following represents the authors' views of EPA's current position on wetlands mitigation banking as it relates to the Section 404 regulatory process.

EPA views wetlands mitigation banking as a comprehensive advanced planning approach for compensating for the unavoidable loss of wetlands or wetlands functions resulting from development actions where mitigation cannot be achieved at the site of impact. It differs from most off-site mitigation in that mitigation for more than one project is aggregated and effected in advance at a single large site. The value of the bank is determined using a wetlands assessment methodology, and quantified as "credits" which are "banked" until needed by an approved development proposal requiring mitigation. Creation of a bank includes restoration of existing degraded wetlands or the creation of new wetlands from uplands. Because the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, restoration should be the first option considered. Simple purchase or "preservation" of existing wetlands will, in only very rare cases, be accepted as mitigation.

While there is no formal Agency policy on banking, EPA has historically taken a position that the concept is experimental. This conservative approach was necessitated by concern over:

- potential misuse (e.g., buy down of alternatives)
- the technical uncertainties associated with creating and restoring wetlands
- potential misunderstandings when applicants construe or anticipate the establishment of a bank as implying ultimate authorization of specific projects
- the adequacy of credit evaluation techniques
- the administrative burdens of establishing a bank
- the legal complexities associated with implementation of a banking agreement
- the need for long term monitoring
- potential long term maintenance requirements

As more is understood about basic wetland science EPA has revisited its position and moved cautiously towards accepting, under some circumstances, banking as a mitigation tool. In fact, in some cases, banking may be the only practicable mitigative measure available to meet a no net loss goal. For example, the banking concept could be used quite effectively for those projects where numerous smaller wetland tracts are affected. If a project, such as highway construction, would destroy three half acre wetland parcels, the bank could allow for appropriate mitigation. On an individual basis, creation or restoration of three separate tracts might not be economically or environmentally desirable. Further, because a bank must be created before the natural wetlands are destroyed, the regulatory and resource agencies have a good indication of what they're getting before they commit to a mitigation plan. With appropriate long range planning, banking can serve as a mechanism to reduce the level of conflict involved in permitting decisions. This reduces project delays and the negative views that some have of the 404 process.

In any specific case, before wetlands banking is accepted as a viable form of mitigation, several requirements should be considered in detail. At a minimum, project proponents must be able to demonstrate that:

- all wetland losses are unavoidable
- all on-site mitigation alternatives, including minimization, have been pursued

- the proposed mitigation plan allows the project to proceed without a net loss in wetlands functional values and acreage
- the site has been acquired by easement, fee title or other legally binding agreement
- construction of the bank has been completed and it is functioning as proposed
- the applicant has the ability to manage the bank or provide a manager to regulate credits and withdrawals
- the bank is located within the same ecoregion and habitat type as the disturbed site
- a plan has been developed to insure appropriate monitoring and reporting on the success of the bank in terms of compensation of wetland values
- a Memorandum of Agreement is in place to insure the long-term operation and maintenance of acreage and functional values

In summary, while EPA remains cautious in accepting mitigation banking, the Agency realizes that in some cases it is an innovative and effective way to mitigate the negative impacts associated with the destruction of wetlands. Once a project passes the 404(b)(1) Guidelines alternatives test, all other practicable minimization has been incorporated, and on-site mitigation fully considered, mitigation banking may be an acceptable method to reduce project impacts to a level below the threshold of significant degradation. Of course the ultimate approval for using credits from the bank is subject to specific criteria, several of which are mentioned above.

MITIGATION PLAN FOR THE PORT EVERGLADES AUTHORITY'S TURNING NOTCH PROGRAM

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INTRODUCTION

The Port Everglades Authority is located on the Southeast Cost of Florida and is Florida's deepest Port, 2nd in the world for cruise ship's, 2nd largest Petroleum transshipment Port in the U.S., 1st Foreign Trade Zone in Florida, and had the 1st Gantry Crane in South Florida.

Within the next 5 years, a total of over $500 million will be spent within the boundaries of the Port's jurisdictional area between both the Port and Private enterprise. The private sector expansion projects will include several world class Hotels, a Market Place, a Convention Center, and Office Buildings.

Port expansion will include roadway improvements, cruise terminals, 4,500 Lf of Bulkhead, 3,000 Lf of crane rail, up to 6 low & high profile cranes and 150 ac container facility.

To obtain permits for this new Southport terminal facility, the Port Authority was involved in a Public Hearing, EIS, Administrative Hearing. The project took 4 years to be permitted at a cost of approximately $1.5 million dollars.

The key to the Southport Container Facility lies in the construction of a Turning Notch needed to to turn the new 950' container vessels around and position them dockside to the loading/unloading facility. The notch construction is also important in reducing the cost of operations by reducing the number of tugs needed to handle these ships.

The project was conceived in 1981 and conceptual plans developed in mid 1982. At this time, the Port's Master Plan was developed and incorporated the Turning Notch and container facility in its plan through the year 2000.

The Port visited all the permitting and commenting agencies which would have input to this project and incorporated the agencies salient recommendations into the permit package which was finally submitted November, 1984.

In the late 50's and early 60's, plans called for the construction of a second Turning Basin of 70 acres to be built in the Port's 70 acre mangrove forest. The plans were delayed for lack of funding and the project was resurrected in the early 1980's.

The project was reduced from a full sized Turning Basin to a Turning Notch which calls for the impact to 18 acres of mangroves instead of the 70 acres associated with the Turning Basin plans. The Port Authority has mitigated the potential impact by a reduction in plans to the smallest area necessary to accommodate the needs to turn these large ship.

However, to compensate the loss of the 18 acres, the Port Authority developed a multi-facted program which will entail 95 acres of mitigation for the this needed development.

The Port choose to construct its mitigation in John U. Lloyd State Recreational Area, for the following reasons:

1. It's the fourth most utilized Park in the State of Florida's Park system. As such, the benefits of the project will benefit not only the local population but many out of state visitors.

2. The area is only 600 feet east of the proposed project across the Atlantic Intracoastal Waterway. As such, little impact will be felt by the local ecosystem, therefore reducing biological impact to a minimum.

3. Because the area chosen is in a State Park, the improvements developed by the Port on Park property will not undergo developmental pressures and these improvements will remain intact.

The program consists of the following:

1. The creation of 23-25 new acres of wetlands within the surrounding area of the Port Authority.

This program entails the removal of exotic plant species such as Brazilian Peppers and Australian Pines; the scraping down of uplands to intertidal elevation and the planting of approximately 160,000 red mangrove seedlings currently growing in the Port's mangrove nursery.

2. Provide for 7,300 Lf of native limerock riprap.

The riprap has several benefits such as - stabilization of the shoreline; provide habitat for juvenile marine organisms; dissipate wave action generated by boat wakes so that the newly planted seedings will not be damaged and protect the new wetlands from floatable materials.

3. Provide for a manatee refuge.

Currently there is not a safe haven for manatees which frequent the east side of the Intracoastal Waterway. The project calls for the dredging of a 3 11/2 acre "doughnut" shaped creek to a depth of -5' MLW which will enable the manatees to utilize this area at all stages of the tidal. In addition, floating barriers will be provided to prevent boaters from entering this area.

4. The last aspect of this project entails the construction of an educational facility which will have both audio/visual capabilities. This facility will be donated to the Park for utilization in their education programs which address endangered species and wildlife preservation.

The Port had requested a permit of 10 years to be able to ensure proper monitoring of this project. As it stands, the Port will be monitoring survival rates of the mangroves, detrital export, marcoinvertebrates, ichthyofauna and avainfauna for 7 years on a quarterly basis.

The total cost for the project is estimated at $2.3 million dollars with monitoring running about $800,000 for the study, and construction to run about $1.5 million.

Lastly, to ensure permit issuance and to act in good faith with the community, the Port Proposed and entered into a perpetual conversation easement with the State of Florida. Thus, by this act, future Port development precludes any additional impact to the remaining 50 acres of mangrove forest.

Solid Fill Causeways on Alaska's Beaufort Sea Coast—Their Influence on Coastal Oceanography and Fishes

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The oilfields in the vicinity of Prudhoe Bay, on the North Slope of Alaska supply almost 25% of domestically produced oil in the United States. Two causeways have been constructed into the shallow Beaufort Sea to provide access to nearshore oilfield facilities (Fig. 1). One serves the production and drilling islands for the Endicott oilfield, while the other, West Dock, supports the Prudhoe Bay oilfield dock and enhanced oil recovery facility, and is the focus of this paper.

The nearshore central Beaufort Sea is quite shallow and deep- water ports are not available. Dock facilities, therefore, have been placed on solid fill gravel causeways. The dockhead on West Dock is located 1.6 miles from shore on an 1.8 mile causeway. It is situated on the 7 ft contour, and passage to the dock face is kept at a depth greater than 9 ft by dredging. The causeway out to the dockhead was completed in 1976.

The primary function of this dock is to receive module bearing barges. Because of the extreme climate on North Slope, most of the facilities in the oilfield are built in modular fashion at construction sites in Oregon and Washington. The modules are shipped to the North Slope during a summer "Sea-Lift", unloaded onto the dock, and then transported by crawlers to their destination where final assembly is completed.

In 1981 a 4000 ft extension was added to the causeway to provide access and protection for a Seawater Treatment Plant (STP) that filters and de-oxygenates seawater for injection into the oil reservoir as a secondary recovery technique. This Waterflood process will result in recovery of an additional billion barrels (1 bbl = 42 gal) of oil from the Prudhoe Bay field. The 610 ft long STP was built in Korea as a barge then towed to Prudhoe Bay where it was floated into place and ballasted to the bottom in August 1983. It began operation in June 1984 and now supplies 740,000 bbl (31,000,000 gal) of treated seawater daily through 36 and 40 inch pipelines buried in the causeway. The intake depth of the STP is 12 ft and the causeway now extends 2.5 miles from shore.

Nearshore Oceanography

It is during the 3-4 month summer when the causeway can have an effect on nearshore water masses. The dynamic oceanographic period is from approximately mid-July through the latter part of September when there is open water along the coast. During winter, ice freezes to a depth of 6 ft, ocean currents are low, and the influence of the causeway on oceanography and fish is negligible.

Because of the shallowness of the nearshore seas (Fig. 1), current patterns are primarily a function of local winds. Winds are bimodal, being predominantly from the ENE and WSW. The easterlies are the more common of the two, but inter-an-

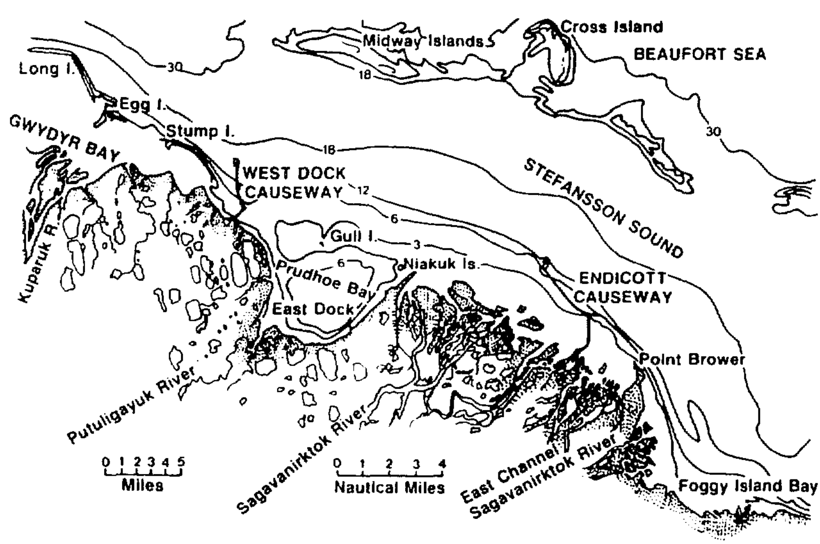

Figure 1. Causeways and bathymetry (ft) in Prudhoe Bay region, Alaska.

nual variability is high. Average speed is approximately 13 miles/h (Dames & Moore 1988a); however both speed and direction can be quite variable. Directional persistence can frequently be measured in hours, but occasionally the wind will blow from one direction for longer than a week (Savoie and Wilson 1986).

The summer nearshore region of the Beaufort Sea is dominated by a band of brackish water. The early open water period (break-up) is strongly influenced by the high volume of melt water from local rivers. The surface water is quite fresh, with little mixing with the deeper marine layer. The majority of the discharge of the rivers on the North Slope occurs early in the summer. Lower rates thereafter, and increased mixing by summer storms result in the nearshore waters becoming more marine in character as summer progresses (Colonell and Niedoroda 1988).

Easterly winds create an upwelling situation along the shoreline of the Beaufort Sea. Ekman transport causes the surface waters to move offshore, which results in the onshore and upward movement of the deeper marine water, occasionally to less than 6 ft from the surface. Brackish water (10-15%) at the surface is maintained along shore by continued input from rivers (Savoie and Wilson 1986; Colonell and Niedoroda 1988).

Subsequent west winds can move the marine water further onshore as a result of the positive surge and water level rise. Tidal range is very low in this region (0.5 ft) but wind driven positive and negative surges can change water levels more than 3 ft (Savoie and Wilson 1986). A mid-summer transition to more marine condition occurs at a change from an east to west wind. Late summer surface salinities range from 15 to 30% (Savoie and Wilson 1986).

The causeway can influence the nearshore distribution of water in two ways. It disrupts the flow of brackish water along-shore; and surface divergence in the lee of the tip of the causeway can result in bringing bottom water to the surface. These effects are not significant during early summer, when the nearshore is dominated by freshwater, and late summer, when conditions are more uniformly marine. Mid-summer, when stratified conditions prevail, will see the greatest extent of the influence of the causeway: up to 6-8 miles downwind of the structure in extreme cases. Occasionally temperatures may range to 5C below ambient levels in the immediate vicinity of the causeway and salinity may reach 15 ppt above ambient in the lee of the tip, as a result of the upward mixing of marine water. These effects are transient due to wind direction switching between east and west. In addition, during east winds natural upwelling through the inlets between the barrier islands is an additional source of marine water to the lagoon (Savoie and Wilson 1986).

During east winds (Fig. 2), barrier islands west of the causeway can restrict mixing with offshore water and thus maintain the temporal and lateral extent of the effect. If the wind persists for 3 to 4 days, marine water may fill behind Stump Island. Simultaneously, upwelled marine water may be flowing through channels between the barrier islands. The causeway may enhance local upwelling by entrainment effects in the lee of the causeway resulting in an incursion of bottom water into shallower than expected depths (Fig. 3) (Savoie and Wilson 1986).

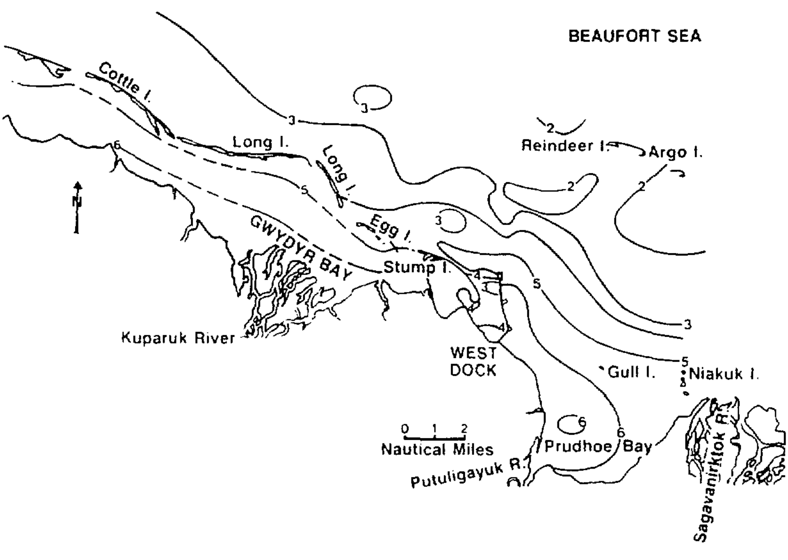

Figure 2. Sea surface temperatures (°C), east winds, 7-29-83. (Savoie & Wilson 1984)

During a midsummer west wind event, brackish water returns to the eastern lagoon and is deflected offshore when it reaches the causeway (Fig. 4). As in the case of the east wind, divergence in the lee of the causeway may bring upwelled water to the surface. Marine water can get into Prudhoe Bay by two methods: flow along the eastern side of the causeway, and flow over the sill of Prudhoe Bay as water level rises in the switch from a negative to positive surge with the change in the wind (Savoie and Wilson 1986).

It is well known that breakwaters and groins change the wave energy reaching the shore. There was concern that a causeway induced change in the pattern of the waves striking Stump Island might result in the erosion or accretion of the island at unusual rates. Examination of aerial photographs through time has documented that the island is continuing to evolve in pre-causeway patterns and rates (Savoie

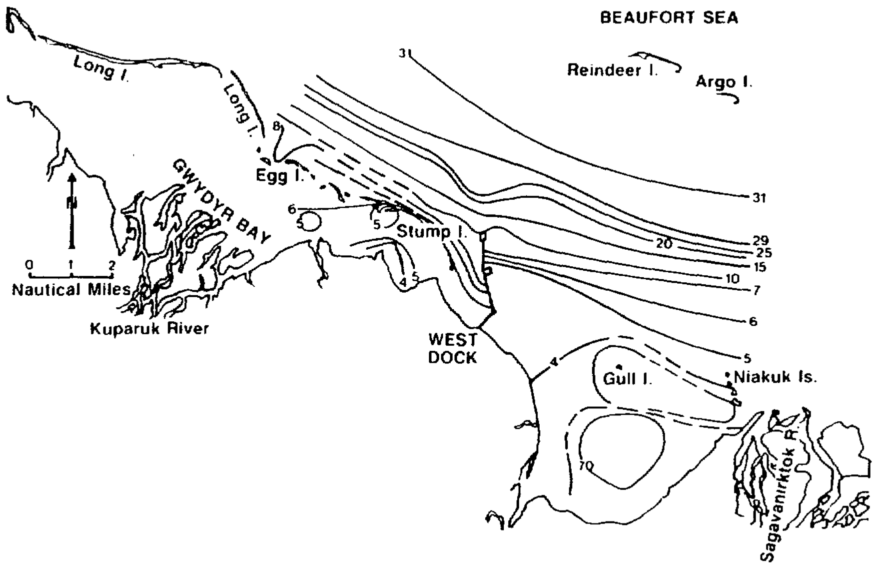

Figure 3. Bottom salinities, east winds, 7-24-84. (Savoie & Wilson 1986) 1984; Morrow J.E. 1980]), broad whitefish, Arctic cisco, and least cisco. All the anadromous fish are from the family Salmonidae. These fish overwinter in the local rivers and move into the nearshore marine/brackish environment to feed during the summer.

1986).

Nearshore Fishes

Causeway induced hydrographic changes can represent changes to habitat used by nearshore fishes. The habitat and population characteristics of the local fishes are important considerations in determining if there has been a detrimental impact due to the causeway.

The primary fishes of interest are two marine species: Arctic cod and fourhorn sculpin; and four anadromous species: Dolly Varden char (historically misidentified as Arctic char [Moulton et al. 1988; Behnke

The relative abundance of these fishes is revealed in the total catch data from a 1985 monitoring study of the area (Fig. 5). Nearshore fyke nets were used to collect the fish. The two marine species were by far the numerically dominant fishes. The least ciscos and char were approximately the same level of abundance, about one-fifth that of the marine species; and the Arctic cisco and broad whitefish were somewhat lower. Arctic cisco young-of-the-year are not included in these comparisons. Sixteen other marine, anadromous, and freshwater species made up the remaining 2% of the summer's catch (Cannon et al. 1987).

Evaluation of the salinity and temperature of the water in which fish are captured allows development of generalities regarding the habitat utilities of the various abundant species (Dames & Moore 1988b; Houghton et al. 1988; Whitmus et al. 1987). Bias in these generalities is a function of the fact that these are summertime data and that the fyke nets used to sample the fish are almost always next to a main-

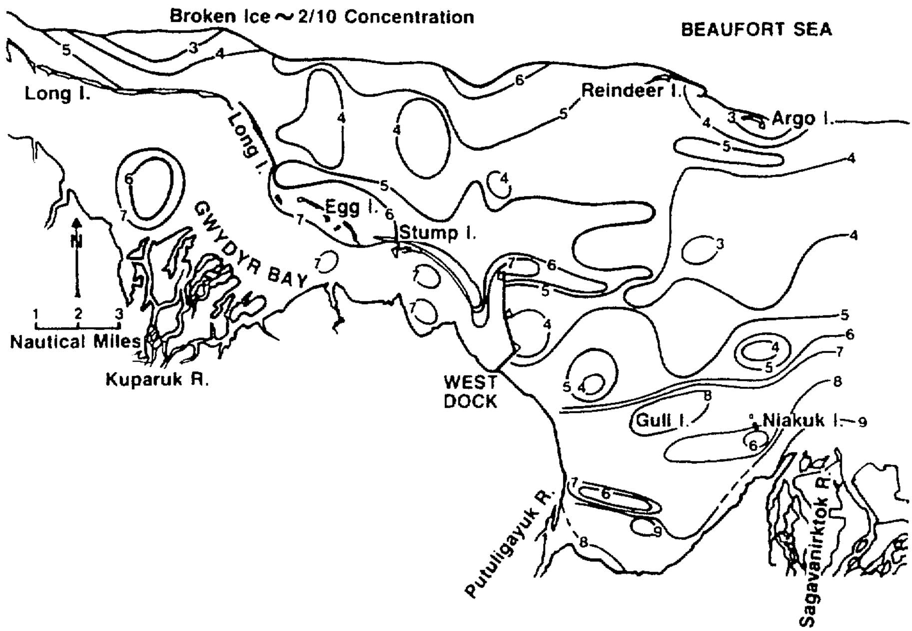

Figure 4. Sea surface temperatures (°C), west winds, 8-1-84. (Savoie & Wilson 1986)

land or island shoreline.

The large population size and broad distribution of the marine fish render it unlikely that the causeway could have any impact on these fish. Arctic cod are found in water having moderate salinity (15-25%) and cool temperatures (2-6°C). Fourhorn sculpin are found in intermediate temperatures and low to moderate salinities in shallow water.

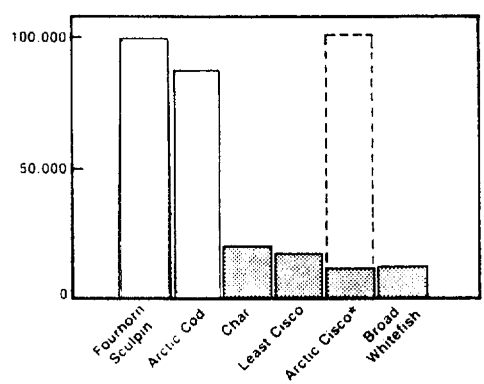

Figure 5. Total catch in the study area (33 miles of coast line, 27 stations) summer 1985. Marine and anadromous fishes are represented by open and grey columns. Arctic cisco (*) young-of- the-year migrants from Canada are shown by the dashed column. (Cannon et al. 1987)

The two anadromous fishes representing the extremes of salinity preferences are the broad whitefish and Dolly Varden char. Broad Whitefish are generally associated with the warm (12°C), low salinity water in the vicinity of river deltas. Large tagged fish have demonstrated that they will swim around the causeway but, in general, the distribution of these fish is limited to the vicinity of the river of origin and does not range to the vicinity of the causeway (Moulton et al. 1986). It is, therefore, unlikely that the causeway could impact these populations.

After age 4, Dolly Varden char become the most tolerant of marine conditions of these four anadromous fish. Younger char prefer low salinity (<8%), cool to moderate temperature (4-10°C) water typical of the early summer. From mid-July to mid-August they apparently do most of their feeding along the barrier islands. As the oceanographic conditions become more marine in mid-summer, they return to the river delta areas. Char range further offshore than the other anadromous species, therefore their distribution is little influenced by the causeway (Moulton et al. 1986).

Arctic cisco appear to prefer moderate temperatures (4-10°C) and low to intermediate salinities (to 16%). The hydrographic changes induced by the causeway can influence the local distribution of this fish.

The Arctic ciscos in the Prudhoe region are a portion of the population that spawns in the Mackenzie River (Gallaway et al. 1983). Years with predominantly east winds result in sufficient current to bring young-of-the-year fish 400 miles to the Colville River where most of the migrants overwinter (Fechhelm and Fissel 1988). The lower Sagavanirktok River lacks sufficient quantity of deep holes to make it an attractive overwintering river. Upon reaching maturity at age 7 or 8, Arctic cisco migrate back to the Mackenzie River to spawn. The small, young-of-the-year arrive in the Prudhoe Bay area in large numbers in late summer after most of the larger fish have returned to local rivers. In 1985, 93,000 young-of-the-year Mackenzie migrants were sampled compared to the 12,000 older fish sampled earlier in the summer (Cannon et al. 1987). Years with weaker east winds or predominantly west winds do not result in this influx of young fish. There was concern that the causeways in the Prudhoe Bay region might have an impact on the passive migration from the Mackenzie River, but examination of the timing of there appearance along the coast revealed that the causeways do not affect their success in reaching the Colville River at a normal rate (Moulton in press).

Least Cisco utilize a wide salinity range (0-24%). Fish up to 3 years of age prefer intermediate temperatures (8-10°C) while older fish utilize a broader range incorporating cooler water (4-10°C). Least cisco in the Prudhoe region represent the far eastern portion of the stock that spawns and overwinters in the Colville River, which is the eastern-most spawning river in Alaska for this species (Moulton et al. 1986). The hydrographic changes induced by the causeway can influence the local distribution of this fish.

Arctic and least cisco are the two species with the greatest potential to demonstrate causeway induced impacts to local populations. Note that "impact" as used here does not include the local changes in distribution that might be a function of the presence of the causeway. For an impact to be significant, it has to result in an effect on the population.

Change in population size is one measure of impact. The mark and recapture techniques used in the study of these fish provide population estimates but unfortunately many of the necessary assumptions are violated and the estimates generated are of little value for trend analyses. Fortunately we have an excellent surrogate in the catch statistics of a commercial fishery on the Colville River.

In October and November there is fishing activity on a commercial basis as well as subsistence fishing by the people of Nuiqsut. Over the past 10 years the combined catch has averaged approximately 48,000 Arctic cisco and 36,000 least cisco annually. Fishing is by gill net through the ice from early October through the end of November (Moulton and Field 1988).

The Arctic cisco data are difficult to use as an indicator of the impacts of the causeway on population size because their abundance is a function of the wind-aided recruitment from the Mackenzie River. For example, the two highest catch rates in the 21 years of record were 1986 and 1987, when fish from the very abundant year-classes of 1979-80 became large enough to be vulnerable to the gill nets used in the fishery (Fig. 6). A prediction that the 1988 catch would be very low because this group would have migrated back to the Mackenzie to spawn has been verified (L. Moulton, pers. comm.). Recruitment was low from 1981 through 1984 so the catch is expected to stay low for the next three years. From 1985 through 1987 the greater durations of east wind resulted in good recruitment to the area. The 1988 summer consisted of predominantly west winds and consequently the number of Arctic cisco that arrived in the central Beaufort Sea region was extremely low (D. Schmidt, pers. comm.). The good catches of the 1979-80 year-classes by the commercial and subsistence fisheries indicated that the effects of the causeway were not impacting the local population.

Since least cisco both spawn and overwinter in the Colville River, evaluation of their catch data is more straight forward. While there is considerable variability in the catch data over the years, there is, nevertheless, a significant positive slope in catch rate (Moulton and Field 1988). The presence of the causeway has apparently not impacted the ability of this population to grow to catchable size. The 1988 catch rate may prove to be one of the highest on record (L. Moulton, pers. comm.), but as of this writing the data have yet to be analyzed.

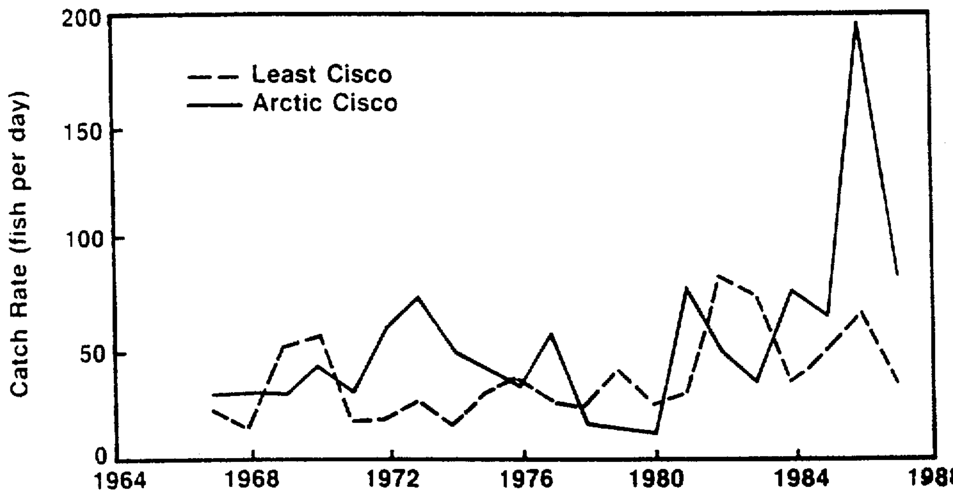

Figure 6. Catch per unit effort (fish/net-day) of least and Arctic cisco during the Fall, through the ice, commercial fishery on the Colville River, Alaska, 1967 through 1987.. (Moulton & Field 1988)

Comparison of growth curves through time is another way to evaluate whether or not population level impacts have occurred to the local fishes. The length-age relation-ships of several studies of Arctic cisco indicate that data collected after the construction of the causeway lie within the envelope of data collected before the causeway (Fig. 7) (Whitmus et al. 1987). The growth rate of these fish has not been affected.

Length-weight relationships provide information on the condition of the fish. Comparisons of the condition of Arctic cisco in different years (Fig. 8) and in dif-

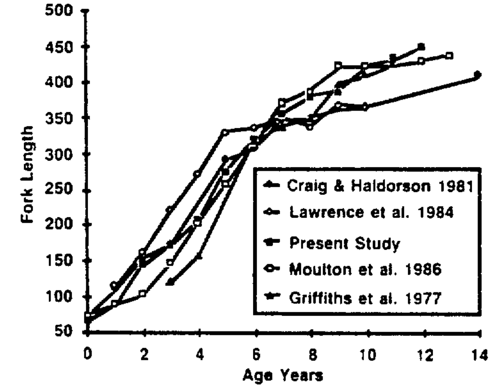

Figure 7. Growth curves of Arctic cisco from various studies and locations along central Beaufort Sea coast. (Cannon et al. 1987)

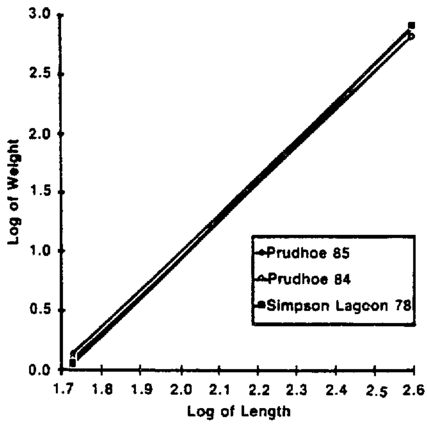

Figure 8. Condition of Arctic cisco (length vs weight) from different years in central Beaufort Sea region. (Whitmus et al. 1987)

ferent areas for the same year (Fig. 9) show no differences. The same is true of similar comparisons made of least cisco data (Whitmus et al. 1987). The condition of these fish has not been altered.

Conclusion

Because Beaufort Sea anadromous fishes are so intimately tied to brackish water, and because the nearshore band of brackish water can be disrupted by a solid feature normal to the shoreline, causeways have become controversial structures in this area. Localized changes in the distribution of water quality (temperature and salinity) have been documented, but these are mostly in the range of natural variability. Impacts to fish have been speculated but, after about $20 million of effort over a period of study in excess of 10 years, none have been demonstrated beyond ephemeral, localized changes in distribution. Hence, the periodic local changes in the habitat of these fishes are not significant in terms of impacting the population characteristics evaluated to date.

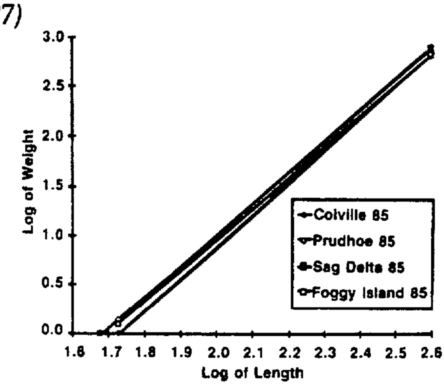

Figure 9. Condition of Arctic cisco (length vs weight) from different areas during the same year in central Beaufort Sea region. (Cannon et al. 1987)

Literature Cited

Behnke, R.J. 1984. Organizing the diversity of the Arctic charr complex. *In* L. Johnson and B.L. Burns (eds.). Biology of the Arctic charr, Proc. Int. Symp. on Arctic Charr. Winnipeg, Manitoba, May 1981. Univ. Manitoba Press. Winnipeg. P. 3-21.

Cannon, T.C., B. Adams, D. Glass, and T. Nelson. 1987. Fish distribution and abundance, Chapter 1. *In* Vol 6, 1985 Final Report for the Endicott Environmental Monitoring Program. Prepared for the U.S. Army Corps of Engineers, Alaska District, Anchorage, Alaska. 129 p. + Append.

Colonell, J.M., and A.W. Neidoroda. 1988. Nearshore oceanographic processes of potential importance to marine and anadromous fishes. *In* Draft Proceedings of the Arctic Fish Conference, April 5-7, 1988. Minerals Management Service, Anchorage, Alaska. p. 78-90.

Craig, P.C., and L. Haldorson. 1981. Beaufort Sea barrier island-lagoon ecological process studies: Final Report, Simpson Lagoon. Part 4, Fish. Res. Unit 467. *In* Envir. Assess. Alaskan Cont. Shelf, Annu. Rep. Prin. Invest. BLM/NOAA, OCEAP. Boulder, Colo. 7:384-678.

Dames & Moore. 1988a. Affected environment, Chapter 3. *In* Lisburne Offshore Project, Environmental Assessment. Prepared for ARCO Alaska, Inc., Exxon USA, and Standard Alaska Production Company. 90 p.

Dames & Moore. 1988b. Anadromous fish habitat usage, Appendix B. *In* Lisburne Offshore Project, Environmental Assessment. Prepared for ARCO Alaska, Inc., Exxon USA, and Standard Alaska Production Company. 45 p.

Fechhelm, R.G., and D.B. Fissel. 1988. Wind-aided recruitment of Canadian Arctic cisco (*Coregonus autumnalis*) into Alaskan waters. Can. Jour. of Fish. & Aqua. Sci. 45:906-910.

Gallaway, B.J., W.B. Griffiths, P.C. Craig, W.J. Gasey, and J.W. Helmericks. 1983. An assessment of the Colville River delta stock of Arctic cisco-migrants from Canada? Biol. Pap. Univ. Alaska. 21: 4-23.

Griffiths, W.B., J. Den Beste, and P. C. Craig. 1977. Fisheries investigations in a coastal region of the Beaufort Sea (Kaktovik Lagoon, Barter Island, Alaska). Arctic Gas Biol. Rep. Ser. 40. 190 p.

Houghton, J.P., C.J. Whitmus, and A.W. Maki. 1988. Habitat relationships of Beaufort Sea anadromous fish: integration of oceanographic information and fish catch data. *In* Draft Proceedings of the Arctic Fish Conference, April 5-7, 1988. Minerals Management Service, Anchorage, Alaska. p. 150-175.

Lawrence, M.J., G. Lacho, and S. Davies. 1984. A survey of the coastal fishes of the southeastern Beaufort Sea. Can. Dep. Fish. and Oceans, Tech. Rep. Fish. Aquat. Sci. No. 1220. 178 p.

Morrow, J.E. 1980. Analysis of the Dolly Varden char, *Salvelinus malma*, of northwestern North America and northeastern Siberia. *In* E.K. Balon (ed.). Charrs: salmonid fishes of the genus *Salvelinus*. Dr. W. Junk Publishers. The Hague. P. 323- 338.

Moulton, L.L. In press. Recruitment of Arctic cisco in to Colville Delta in 1985. Biol. Pap. Univ. Alaska.

Moulton, L.L., and L.J. Field. 1988. Assessment of the Colville River fall fishery, 1985-1987. Final Report to ARCO Alaska, Inc., North Slope Borough, and the City of Nuiqsut. 41 p. + Append.

Moulton, L.L., L. J. Field, and S. Brotherton. 1986. Chapter 3, Assessment of the

Colville River fishery in 1985. *In* Colville River Fish Study, 1985 Annual Report. Prepared for ARCO Alaska, Inc., North Slope Borough, and City of Nuiqsut. 72 p. + Append.

Moulton, L.L., B.J. Gallaway, M.H. Fawcett, W.B. Griffiths, K.R. Critchlow, R.G. Fechhelm, D.R. Schmidt, and J.S. Baker. 1986. 1984 Central Beaufort Sea Fish Study. Chapter 3. *In* Vol 2, Prudhoe Bay Waterflood Project Environmental Monitoring Program, 1984. Final Report. Prepared for Department of the U.S. Army, Corps of Engineers, Alaska District Anchorage, Alaska. 322 p.

Savoie, M.A. 1986. Prudhoe Bay Waterflood Project physical marine processes monitoring program 1985. *In* Prudhoe Bay Waterflood Environmental Monitoring Program, 1985. Final Report. Prepared for U.S. Army Corps of Engineers, Alaska District, Anchorage, Alaska. 32 p. + append.

Savoie, M.A., and D.E. Wilson. 1986. Physical Marine processes monitoring program 1984. Final Report. *In* Vol 1, Prudhoe Bay Waterflood Environmental Monitoring Program, 1984. Prepared for the U.S. Army Corps of Engineers, Alaska District, Anchorage, Alaska. 195 p. + Append.

Whitmus, C.J., T. C. Cannon, and S. S. Parker. 1987. Age, growth, and condition of anadromous fish, Chapter 5. *In* Vol 7, 1985 Final Report for the Endicott Environmental Monitoring Program. Prepared for the U.S. Army Corps of Engineers, Alaska District, Anchorage, Alaska. 34 p.

URBAN ESTUARY MITIGATION WORK GROUP

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Introduction

In early 1986, an ad hoc technical committee of resource agency representatives, tribal biologists, university researchers, and port industry representatives was assembled to review estuarine mitigation issues in Puget Sound, Washington. The "Urban Estuary Mitigation Work Group" is concerned with improving the technical aspects of compensation for fish and wildlife habitat lost to development uses and activities.

The mitigation work group has completed several important tasks and continues as a forum for analysis of chronic estuarine mitigation issues. This paper describes the impetus leading to formation of the work group, the work group's objectives, and reports on the progress made by the group thus far.

Background

Individuals familiar with wetland and coastal resource management and development decision-making are aware of the role mitigation plays in development permit process. Briefly, mitigation is the means of compensating or offsetting the unavoidable adverse effects of development. In the context of intertidal estuarine environments, permitting agencies determine the net anticipated adverse effects on fish and wildlife resources due to proposed projects and prescribe appropriate project mitigation as a means to compensate for these impacts (Ashe 1982, Blomberg 1987).

There is growing evidence in the Pacific Northwest (Mitchell 1987, Cooper 1987, Good 1987), and elsewhere (Race 1985), that mitigation projects have had only limited success in replacing estuarine intertidal resource functions and values lost to development. There are two basic reasons for the limited success of mitigation actions, problems shared by agencies and the development community:

(1) *Institutional shortcomings* Inadequate identification of specific fish and wildlife functions and values lost to development; Inconsistent and poorly defined mitigation objectives; Hasty mitigation project design; and, Insufficient emphasis on project accountability.
(2) *Technical difficulties* Arising from an inadequate understanding of estuarine ecosystems and the experimental nature of habitat creation and restoration techniques

For the most part very little detailed detailed knowledge is available about the outcome of individual mitigation projects due to inconsistent, inadequate quantification of fish and wildlife habitat functions and values. Consistent parameters for measurement of estuarine resource values are not used, and the frequency and duration of monitoring and evaluation of particular mitigation projects is variable. As a result, very little information is available to grade the individual and relative success of mitigation actions. Compounding the problem is that a majority of estuarine mitigation projects in Puget Sound are in heavily industrialized areas where opportunities for project mitigation are scarce and where replacement of existing marginal fish and wildlife habitat areas through mitigation, as minimally required by the permit decision-making process, may not be providing effective estuarine resource values or counteracting historic impacts to estuarine systems.

Therefore, controversy exists among resource agency biologists and development interests concerning the long-term acceptability of estuarine mitigation. Each mitigation project requires new and hasty efforts to determine the focus of biological evaluation, fish and wildlife objectives for project mitigation, and site design. Little continuity is evident among projects. Little useful and transferable information or data is available from past mitigation efforts for application to succeeding mitigation projects.

In general, there is only a presumption that we are doing all that we can in terms of providing optimal fish and wildlife habitat value and offsetting the cumulative effects of estuarine development impacts. Moreover, many are concerned that mitigation projects have not been efficiently managed and that opportunities for economies of scale and more effective capital construction expenditures have been foregone. Information and experience is not available to ensure that mitigation project funds are spent effectively and there is no assurance that constructed projects result in effective mitigation.

In response to these problems, a regional ad hoc group of agency, tibal, academic, and industry representatives began to explore means of:

(1) Improving the technical aspects of mitigation in urbanized estuaries;
(2) Increasing the level of certainty for the success of mitigation projects; and,
(3) Improving predictability in the mitigation planning and permit review process.

The Urban Estuary Mitigation Work Group began meeting informally in the spring of 1986. The mitigation work group is a technical committee of local, state, and federal agencies involved in the development review process. Participants include: Washington State Agencies—Department of Ecology, Department of Fisheries, Department of Wildlife; Federal Agencies—Army Corps of Engineers, Environmental Protection Agency, Fish and Wildlife Service; Regional Indian Tribes—Muckleshoot Indian Tribe, Puyallup Tribe of Indians; University of Washington, Fisheries Research Institute; Port of Seattle and the Port of Tacoma.

The mitigation work group has focused on the technical aspects of mitigation rather than consideration of mitigation policy. It is generally recognized that compensatory mitigation is only one part of the management framework for estuarine habitat maintenance and protection, albeit an essential one. The mitigation work group recognizes that individual projects must stand on their merits, including precise justification of all dredge and fill impacts before mitigation comes into focus as a management alternative.

The primary findings of the mitigation work group concerning the present uncertain status of mitigation implementation in Puget Sound estuaries are:

(1) Urbanized and developed estuaries have been the site of intensive historic development and are the focus of continuing significant alteration.
(2) The goals and objectives for mitigation projects are not precisely

defined in terms of specific fish and wildlife values.
(3) Biological and physical monitoring is inconsistent and ambiguous.
(4) Mitigation project design and evaluation is not technically rigorous and many existing techniques for mitigation of fish and wildlife habitat are limited or infeasible in developed estuaries.
(5) Little data and information has been obtained from past mitigation projects for application to future projects.
(6) Individual mitigation projects have not been designed and implemented to benefit estuarine systems. The cumulative effect of continuing development and associated mitigation actions is not adequately known.
(7) Maintaining and providing adequate fish and wildlife habitat in developed estuaries is an essential element of the health and economic value of Puget Sound.

The mitigation work group determined that there is a general lack of confidence in mitigation stemming from inadequate and ineffectively applied technical expertise. The work group set out to correct this problem such that mitigation could become a more reliable and durable management tool.

Historical Context For Mitigation

The Urban Estuary Mitigation Work Group has focused on intensively development estuarine areas in Puget Sound because these areas are the center of continuing development uses and activities and are considered critical to resource agenices and tribal interests due to the extent of past alteration of these areas. Urbanized estuaries are defined by the work group as having the following characteristics:

(1) An altered floodplain
(2) Loss or degradation of the majority of intertidal wetland habitats—principally mud and sand flats
(3) Highly industrialized shorelands
(4) Intensively regulated and reduced fresh water discharges to the estuary compared with historic conditions

These are the areas where mitigation is most important and where the outcome or effectiveness of most habitat mitigation projects is either unknown or incompletely documented (Cooper 1987). In Puget Sound these areas include the Snohomish River and Port Gardner Bay in Everett, the Duwamish River and Elliott Bay in Seattle, and the Puyallup River and Commencement Bay in Tacoma. Because the mitigation work group emphasizes analysis of mitigation actions in urbanized estuaries, a brief description of the historic effects of development in the Duwamish estuary, the industrial and port center of Seattle, is included here to illustrate one of the primary concerns of the work group.

125 years of development in the Duwamish estuary

Prior to settlement by large numbers of immigrants the Duwamish River followed a meandering course through significant areas of tidal wetlands to Elliott Bay. The estuary included approximately:

- 440 acres of medium depth habitat (water area measured from minus 15 feet MLLW to 0 feet MLLW)
- 1270 acres of tidal marsh (vegetated area between plus 3 feet MLLW to plus 8 feet MLLW)
- 1230 acres of tidal swamp (shrub and forest wetlands extending to MHHW)
- 1450 acres of estuarine shallows and flats (measured from MLLW upward to the lower limit of wetland vegetation)

The historic watershed of the estuary was approximately 1640 square miles, with 1900 linear miles accessible to anadromous fish.

Significant reductions and alterations in each of these habitat types are evident compared with the present "urbanized" estuary (refer to Figure One, Blomberg 1988). Development focused on dredging and filling of estuarine wetlands and shallows to create a deep draft navigation channel bordered by industrial uses in former estuarine intertidal flats and emergent wetlands. In addition, the watershed of the estuary was also dramatically altered. The drainage area was reduced by 70 percent due to extensive water diversions and dams. Only 125 linear miles of streams remain accessible to anadromous fish, a 93 percent reduction. Meanwhile, an initial resource based economy changed to a diversified industrial region, accompanied by the large scale introduction of complex contaminants to the estuary, including industrial discharges and pollutants from modern urban activities.

The contemporary estuary is a shadow of the historic system. No tidal swamp habitat remains and only 25 acres of tidal marshes are present in the estuary (a 98 percent reduction). Intertidal mud and sand flats were reduced by 98 percent. 125 years of development substituted a linear channel with developed uplands for the former meandering channel, fringed with robust estuarine wetlands. Freshwater discharge volumes to the estuary were reduced 70 to 75 percent. In excess of 4900 acres of industrial and commercial development is located in the former intertidal footprint of the estuary. Finally, only seven percent of the historic stream habitat for anadromous fish remains in the estuary's watershed.

Alteration of the hydrology and fish and wildlife habitat of the Duwamish estuary has significantly reduced the capacity of the estuary to rear and feed juvenile and adult fish and wildlife.

Similarly, historic development in Commencement Bay and the Puyallyp River estuary (Tacoma) eliminated approximately 1000 acres of intertidal marshes. No significant intertidal marsh area remains from the historic estuarine system. Development in Port Gardner Bay and the Snohomish estuary (Everett) decreased intertial wetlands by approximately 75 percent.

The scale of disruption and disturbance noted here underscores the need to refine mitigation practices to effectively offset and reverse the alteration of remaining estuarine fish and wildlife habitat.

Urban Estuary Mitigation Work Group Activities

Given the historic effect of development on important estuarine resources and the existing uncertainty about our ability to appropriately compensate for the effects of new development projects on the remaining estuarine resources, the goal of the mitigation work group became improvement of fish and wildlife habitat mitigation implementation in urban estuaries. In order to achieve this goal, three principal objectives were identified:

(1) *Mitigation Assessment* The work group determined that a consistent and uniform methodology for pre-project and post construction testing, monitoring, reporting, and comparative analysis of development and mitigation sites was needed. This required consensus on the specific fish and wildlife values critical to urbanized estuaries and standardization of the means to evaluate these estuarine resource values for conversion into the criteria necessary for analysis of development projects and associated mitigation actions.
(2) *Mitigation Techniques* Using the results of Objective One, the work group decided to concentrate on generating and verifying new techniques for mitigation and enhancement of fish and wildlife habitat in urban estuaries.
(3) *Mitigation Planning and Decision-Making* The work group determined to use these important new perspectives to advance and establish fish and wildlife habitat mitigation as a planning tool—using a planned estuarine systems approach to mitigation in place of single, isolated, and uncertain mitigation actions.

Objective one-mitigation assessment

The mitigation work group is nearing completion of the first objective. The first objective is fundamental to making progress on the chronic shortcomings of present mitigation practices. A brief discussion of the reasoning and ecological principles used by the work group follows.

The work group decided to approach the problem of assessing fish and wildlife habitat values affected by development (and proposed for compensation at mitigation sites) by identifying the functional relationships between estuarine fish and widlife species and estuarine habitats, i.e., describing guild associations, species acting together as assembleges, and using habitat information characterizing the species assemblages as the basis for evaluating development and mitigation actions.

First, the group identifed seven habitat types important to estuarine systems in Puget Sound: (1) emergent marsh; (2) eelgrass beds; (3) protected mud flats; (4) sand flats; (5) gravel/cobble exposed beach; (6) deep subtidal (demersal) channel areas; and, (7) water column.

For each of these habitats a guild list of species was described. Species were selected based on ecological and socio-economic importance, emphasizing species which are dependently linked to specific habitats through: (1) consumption and feeding; (2) need for refuge from predation and disturbance; and (3) reproduction. A total of 92 species were identified.

Combining the habitat types and species lists, a series of matrices were developed to identify specific feeding, refuge, and reproductive requirements provided by each habitat. Particpants in the work group entered numerical values in more than 3000 matrix cells, indicating the relative value of each of the guild species for specific habitat dependence. The matrix process was iterative. A second phase matrix was formulated (refer to Figure Two) which highlighted the most significant species/habitat functional relationships identified in the first matrix. The second matrix was used to gather specific information on each of the habitat functions noted above—feeding, refuge, reproduction.

The detailed responses to the second phase matrix were then combined with a detailed literature search, intended to verify and add further detail to species/habitat interrelationships identified. Following the second matrix, all habitat data was compiled and a "guild questionnaire" was prepared. The questionairre focused on each of the species/habitat linkages and was sent to over one hundred environmental scientists with particular expertise regarding specific species/habitat linkages. This step expanded the data gathering beyond the work group participants.

This data is now being formed into a draft "intertidal habitat biocriteria test protocol". This document respresents the work group's best effort to identify the species/habitat linkages (called biocriteria) known to be important to estuarine systems. Drawing from data gathered from the matrix process, the draft protocol proposes methods for assessing the extent and magnitude of the species/habitat assemblages selected for evaluation. The advantage of the protocol is; (1) consensus on the kinds of organisms that must be evaluated to test for fish and wildlife habitat value at specific sites and (2) agreement on the standard techniques for measuring and reporting information detailing these habitat attributes.

The draft protocol will be subjected to peer review in the form of a specialized workshop. The work group is inviting academic, agency, and environmental consultant experts in estuarine science to a workshop planned for March-April 1989. The protocol, and the steps leading to its development, will be presented to the workshop such that comments for changes in approach and methods can be obtained from a broader base of environmental experience and knowledge.

The final product of Objective One will be publication of the workshop proceedings and preparation of a revised urban estuaries mitigation protocol.

Continuing Objectives

The mitigation work group has made significant progress to establish consensus on the important environmental parameters that must be measured to reach mitigation decisions and the means for quantifying information required for mitigation. The estuarine mitigation protocol will also form the basis for defining precise objectives for proposed mitigation actions.

Building on the protocol document, the work group intends to move forward with analysis of new and more effective mitigation techniques and, finally, formalizing technical approaches to mitigation planning.

The mitigation work group has been supported by funds from the Port of Seattle and the Region X office of the EPA.

References

Ashe, D. 1982. Fish and wildlife mitigation: description and analysis of estuarine applications. Coastal Zone Management Journal 10 (1 and 2).

Blomberg, G. 1987. Development and mitigation in the Pacific Northwest. The Northwest Environmental Journal 3(1).

Blomberg, G.; Hickey, P.; and, Simenstad, C. 1988. Changes in Duwamish River estuary habitat over the past 125 years. Proceedings—First Annual Meeting on Puget Sound Research. Puget Sound Water Quality Authority.

Cooper, J. 1987. An overview of estuarine habitat mitigation projects in Washington State. The Northwest Environmental Journal 3(1).

Mitchell, D. 1987. Creation/restoration—working group report. In Wetland Functions, Rehabilitation, and Creation in the Pacific Northwest: The State of Our

Understanding. Washington State Department of Ecology.
Race, M. 1985. Critique of present wetlands mitigation policies in the United States based on analysis of past restoration projects in San Francisco Bay. Environmental Management 9(1).

BEACH RESTORATION PRESERVATION FINANCING FOR CAPTIVA ISLAND

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I. INTRODUCTION

Beach communities today are looking for sound beach protection measures which can financially and politically be implemented. These beach communities, many of which were fully developed years ago, are increasingly faced with erosion of their beaches and the subsequent threat of the erosion of high-priced commercial and residential property and the erosion of their recreational tourism-based economy.

Although environmentalists call for human retreat from erosion prone areas, beach communities call this position academic, impractical, politically impossible, and probably unconstitutional. As the federal government cuts back its role in erosion control planning, financing and construction, many beach communities are taking coastal protection responsibility into their own hands and are willing to pay the costs to protect their properties and businesses. Several communities chose the effective method of beach nourishment as its' choice of anti- erosion scheme. Beach nourishment simply replaces lost sand with near-by off-shore sand by pumping it up on the beach. Miami Beach renourished a 10-mile stretch of beach over a 4-year period.

Captiva Island Erosion Prevention District's, hereafter "the District", plans to restore their beach require a number of steps to accomplish a final comprehensive beach and shore restoration plan. As part of this comprehensive planning process, a financial plan is needed to specify how best to raise the necessary capital to pay for the project in the most cost- effective manner.

A. Study Purpose

The purpose of this paper [1] is to survey and describe all revenue sources that will allow the District to accomplish its objectives. The survey will include intergovernmental revenues; federal and state grants and contributions, and county revenues; and local revenues to include special assessments, general obligation bonds, special assessment bonds, bond anticipation notes, and any other available revenue.

Each revenue source identified is analyzed from a cost/benefit perspective to ascertain the best single or set of monies to finance the project from a debt management perspective. Based on the project cost estimates [2] and the expected special assessment revenue stream available to the project [3] from various federal, state and local sources, a recommended *financing plan* is presented.

The financing plan sets forth several financing options namely:

—General obligation bonds;
—Special assessment bonds;
—Certificates of indebtedness;
—Bond anticipation notes; and

—Pay as you go.

The recommended solution is based on least cost and public policy considerations.

B. Summary of Findings

Conclusions relative to the financing plan are focused in three key areas of revenue source, financial structure and marketing issues

—Special assessments are the recommended primary source of revenue to pay for the project;

—The use of special assessment revenue bonds is the recommended financial option based on obtaining the highest score of 22 in the financings options matrix analysis;

—Three marketing options should be explored to include private placement, competitive sale and the sale of the District's debt to an existing Florida loan pool; Each option should be evaluated during pre-marketing activity and a final decision should be determined based on the lowest expected true interest cost to the District; and

—Sufficient flexibility should be built into the financing to allow for the calling of bonds or potential refunding of the debt should interest rates change dramatically in a favorable direction for the District or to allow for early payment of a portion of its debt if intergovernmental funds or grants are received by the District prior to final maturity of the debt issued.

C. Background

1. Existing Programs

A variety of erosion control structures have been constructed along Captiva Island's shoreline to include terminal groins, dogbone groins, rip-rap, concrete revetments, timber groins, sand bags, and offshore breakwaters Both sand delivery and placement as part of the protective beach fill and the Blind Pass groin extension and maintenance are currently proposed as part of the overall beach erosion prevention program.

2. Marketability Factors

a. Security of Revenue Base

The primary considerations relative to the marketing of alternative financial structures depend on the following:

-stability of revenue stream;
-ability to pay and willingness to pay;
-credit strength and security of the bonds;
-economic and social factors;
-the amount and nature of the debt and debt service requirements;
-lien position of the revenue stream; and
-natural hazard risk.

b. Competitive Versus Negotiated Sale

There are advantages and disadvantages of a competitive or negotiated sale as noted in the chart 1 below depending upon the debt management option and the nature of the issuer.

c. Opportunities for Credit Enhancement

In order to make the Bonds marketable, they may require some form of credit enhancement given the credit strength of the District and the risk of alternative financial structures, particularly special assessment bonds.

It is expected that bond insurance, if it can be obtained, is likely to be required for both a general obligation bond structure and a special assessment bond structure. A special assessment bond, because they are not a "full faith and credit pledge" of the District, is likely to need hazard insurance or a letter of credit in addition to the bond insurance. The reason for the hazard insurance requirement is the fact that the District is considered to be within a hurricane high-risk area by the rating agencies [4]. Special assessment bonds generally require that the hazard risk be mitigated by some form of insurance or letter of credit, whereas general obligation bonds do not require this kind of credit enhancement.

Bond insurance firms generally require that some form of insurance "front" their default risks on the bonds from some form of uncontrollable circumstance, like an act of God, such as a hurricane. This risk coverage requirement is determined on a case-by-case basis, after review by the bond insurance underwriter.

d. Bank Demand and Private Placement

Since the District is likely to issue less than $10 million in bonds per year, and the project is considered as "public purpose" then commercial banks can purchase the debt and deduct 80 percent of the interest cost of carrying tax-exempt securities. This factor increases the likelihood that local banks will be interested in purchasing this debt as a private placement in their bond investment portfolios.

If the debt is structured as special assessment bonds then they are considered revenue bonds and banks would be precluded from underwriting the bonds under the terms of the Glass Steagall Act. Banks would not be precluded from purchasing the bonds as a private placement as noted above.

II. IMPLEMENTATION PLAN

The special assessment financing approach should be the basis for the recommended marketing strategy for the project. Further analysis is needed to insure that the special assessment revenues pay for the actual project costs as well as the costs to administer the special assessment program.

If the District decides to use a "double-barreled" bond structure with general obligation bonds and a full faith and credit pledge of the District standing behind the bonds then these bonds should be able to be sold competitively at lower cost than a negotiated sale. In this case, special assessments would be the planned source of revenue to pay for the bonds, but should there be a shortfall, then the ad valorem taxing power of the District would be employed, if necessary, to make timely payment of prinicipal and interest. Bond counsel needs to provide a formal opinion to the District as to whether this financing structure is possible for the District.

III. REVIEW OF ADDITIONAL REVENUE SOURCES

The District has made application for project funding from both the state and federal government, which are likely to be available on a reimbursable basis rather than prior to project construction. The current requested amounts are $1,000,000 from federal sources and $1,802,480 from state sources. It is recommended that call features be employed in the final selected financing option structure to allow outstanding project debt to be called and defeased by the amount of federal and state grant monies received for the project. The slight increase in market price the District would pay for the imposition of call features would be offset by the gain from receipt of grant monies.

In addition, the District expects to receive $1.8 million from County sources that are expected to be received prior to project construction and, therefore, will reduce the amount of project costs that would need to be financed with debt.

IV. FINANCING OPTIONS AND RECOMMENDATIONS

The District's beachfill project will have benefits for Captiva Island residents for a number of years (at least ten by current estimates). The costs of the project are equitably borne by the project's beneficiaries over that time period.

The most cost-efficient financing plan is usually derived by reviewing each available revenue source and determining the mix that best fits the particular project's needs and policy goals.

The preceding section, "Review of Alternative Revenue Sources" has identified available monies up-front (surplus funds) and monies available during the course of and following completion of construction (Federal, State, and Local funds). Even with the application of these funds against total construction costs, there is a shortfall that must be met through debt financing.

A. Financing Options

Several debt instruments are reviewed to identify options available to the District and their associated costs and benefits.

1. General Obligation Bonds

The District's enabling legislation grants the ability to sell bonds secured by the general obligation pledge of the District's ad valorem taxing power. The total outstanding District G. O. debt is restricted to $15,000,000. Bonds issued using this security without any credit enhancement are likely to receive a Baa rating from Moody's, which is the lowest investment grade rating on a scale of Aaa to Baa.

2. Special Assessment Bonds

The District's enabling legislation grants the ability to sell bonds secured by annual special assessments against certain properties on the basis of benefits received by that property. These bonds have the assessments as their sole source of payment. These payments do constitute a lien against a property. However, if one property-owner does not make their assessment payment, the loss (temporary or not) cannot be distributed to the other property owners. On this basis, bonds secured in this way are usually not deemed to be as secure as G. O. bonds. We suggest that bonds issued as Special Assessment Bonds would received a Ba rating from Moody's.

3. Certificates of Indebtedness

The District's enabling legislation grants the ability to issue certificates of indebtedness to each land owner benefiting from a specific project according to the amount of benefit received. These certificates require the land owner to make annual payments according to a specific schedule incorporating a rate of interest for a specified amount of time. Land owners are given the option of paying their entire indebtedness up front at a discounted rate.

These certificates can be deposited into an account which effectively pools all certificates of indebtedness payments. This pool of funds can serve as a security source for Special Assessment Bonds. If the financing pool is structured with an adequate analysis of cash flow timing, the pool will serve to somewhat buffer the volatility of the security source for the Special Assessment Bonds. In concept this "pool" structure is no different than special assessment bonds, although historically, as in the case of the Lee County 1981 Captiva Beach Erosion Control Unit financing, each individual property received a loan from a financial institution rather than as described here, where the certificates are pooled.

4. Pay as You Go

The District would need to raise sufficient revenues prior to construction to pay the entire amount of construction costs, less anticipated upfront revenues, for this to be a viable alternative. Given the required revenue increases to pay for project construction costs, this option does not seem practical.

5. Bond Anticipation Notes (BAN's)

BAN's are intended to serve as a bridge between the onset of needs for funds in a particular project, and the fixing of structure and sale of long-term financing. BAN's are issued for various short-term time periods, usually around a year, and pay interest at short-term rates. Issuance costs for BAN's are considerably less than that for bonds. Once construction is completed, and true cost ascertained, the bond issue is structured to pay for that portion of the outstanding BANs. Any unexpended BAN monies are used to pay for the remaining outstanding BANs not met by Bond proceeds.

B. Criteria for Selection and Point Scoring Methodology

The criteria used for selection of the appropriate financing method is based on legal, revenue adequacy, equity, public acceptance, ease of administration, and least cost criteria.

An evaluation matrix is prepared below in Table 1 for purposes of subjectively rating each of the individual financing options using an evaluation criteria with equally weighted numeric values of 1, 3, or 5 assigned to each criterion. Higher numeric values are assigned to those financing options that best satisfied each criterion.

1. Legality

The viability of a particular financing option depends on the legal authority of the District to engage in certain types of financial and contractual commitments. Also important are relevant state and federal laws that may affect the use of a particular financing option. This criterion will be used to evaluate the legal aspects of each financing alternative.

For example, under the legality criterion, if authority to implement a financing option does not exist a value of 1 is assigned. If legal authority exists and no new legislation would be required to implement the charge, a value of 5 will be assigned. If authority to implement a funding option exists, but requires passage of a resolution that may be subject to voter approval prior to taking effect, a value of 3 is assigned.

2. Revenue Adequacy

In order to be of use to the District, each financing option must be capable of generating funds in a quantity sufficient to meet the costs of a program or program element which it is intended to support. Revenues from a potential funding source should be predictable and relatively stable. This evaluation criterion will address the adequacy of funds under each option, including the anticipated stability and reliability of the revenue stream over time.'

Values assigned to the revenue adequacy criterion are based on two factors: (1) the estimated revenue generating capacity of the mechanism and (2) the stability of the revenue stream over time. For purposes of evaluating the individual financing options three levels of revenue generation will be established. Scores of 1,3, and 5 will be assigned based on expected annual revenues. In some instances the revenue adequacy scores might be modified due to instability of the underlying revenue stream.

3. Equity

The concept of equity is important in the evaluation of alternative funding options. Financing mechanisms that impose costs on users in proportion to their demands or usage are generally perceived to be fairer. Charges that are based on factors having little or no relationship to users are viewed as less equitable. This criterion will be used to assess the equity of individual financing options.

Equity can be measured in many ways including ability to pay, benefits received, geographical benefit, and cost-of-service. For purposes of evaluating the financing options, equity is measured in a cost/benefit context. Consequently, higher scores are assigned a particular option if the users are charged roughly in proportion to what it costs them to receive a relative benefit. This philosophy is widely used by utilities (water, sewer, gas, electric, etc.) to calculate rates and charges and has been widely upheld by courts as a reasonable basis for assigning cost.

4. Public Acceptance

Acceptance by the public of a particular financing option is an important consideration in the development of an overall funding strategy. This criterion will be used to judge the potential public acceptance of each financing option.

Public acceptance is generally measured by historical experience with certain financing options as well as comparable experience in other communities with similar circumstances.

5. Ease of Administration

This criterion will evaluate the administrative requirements that each alternative would impose on the District. Some financing options require considerable staff time to establish and administer. These administrative impacts need to be considered in the evaluation of alternative financing options.

Ease of administration is assessed based on the relative difficulty of implementing a financing option in terms of staff time and related District resources.

6. Least Cost

Least cost is measured by average annual debt service and lowest true interest cost to District for a given financing option.

C. Scoring Results

As shown in Table 1, although the special assessment option is more costly, in terms of overall score from the financing options matrix, this option has a score of 22, making it the recommended financing option.

D. Feasibility Analysis

Basic assumptions are presented below which have formed the basis for this analysis. At this point in the financial planning process these assumptions are the best information available. As the project proceeds, the assumptions may need to be modified, which could change the report's conclusions.

1. Special assessments are the preferred source of local revenues to pay for annual debt service.
2. Federal and state revenues sources are only available after project completion. Eligible project costs are available for reimbursement based on construction costs.
3. Special assessments can only be approved and collected after the project is completed so that the appropriate cost/benefit relationships of each parcel can be directly identified.
4. Lee County may commit upfront from $1.3 to $2.1 million to the project. Current pledges are in the $800,000 range.
5. $250,000 will be provided to the project from the West Coast Inland Navigation District.
6. The expected useful life of the project is 10 years.
7. Monies on hand and available to the District that have been collected from the real property tax are not an acceptable source of revenue to pay for the project, but they can be used, if the District determines that it makes good financial sense given opportunity costs for these monies, as a source of security for the bonds to be held in a debt service reserve fund and managed by a trustee.
8. Florida state law historically appears to allow double barreled bonds, i.e. special assessment bonds as the primary source of bond security with a general obligation full faith and credit pledge as a backup contingent credit support. Further clarification is needed on this point from bond counsel as to its legal basis for the District.
9. The estimated $8.8 million cost of the project is within any debt limits imposed on the District as a result of its enabling legislation

Worst case assumptions are employed in the analysis. That is bond anticipation notes, bond insurance, hazard insurance and rating requirements are assumed to be necessary. Whether or not a bond anticipation note is required prior to the bond sale over the term of the project is a marketing issue. Banks and underwriting firms should be interviewed to determine their willingness to purchase bonds whose timing of revenue collection is contingent upon successful project completion. Issuance costs could be reduced and interest capitalized over the construction period.

Analysis was performed for two of the most likely financing structures making use of different debt instruments to determine the most

cost-efficient method of financing the beachfill project:
—G.O. BAN's to provide construction financing, repaid by bond proceeds from G. O. Bonds.
—Special Assessment BAN's to provide construction financing, and Special Assessment Bonds to repay the BAN's.

The total estimated annual cost of financing the project with method one, using general obligation instruments, is $1,051,765 per year. The total annual cost of financing the project with method two, using special assessment instruments, is $1,094,812 per year.

Some of the financing costs may be mitigated through obtaining bond insurance for the issue which, if available, will provide a higher rating on the bonds and lower relative interest cost. Obtaining insurance would be easier for the G. O. structure than for the special assessment structure. In addition, hazard insurance or a letter of credit will likely be a requirement to qualify for bond insurance in either case. We have not given a definitive pro or con opinion on bond insurance since its economic advisability will be relative to the exact financing structure of the project, which is yet to be determined. A final decision would be made just before the bond sale.

REFERENCES

1. Government Finance Associates, Inc. "Captiva Erosion Prevention District Financing Plan Final Report," 71 Broadway, Rm 1301, New York, NY (September, 1987).
2. Applied Technology and Management, "Captiva Comprehensive Beach and Shore Preservation Plan," unpublished report, Gainesville, Florida, (1987).
3. Regional Research Associates, "Economic Apportionment Plan," unpublished report, West Palm Beach, Florida, (1987).
4. Standard & Poors Corporation, "Natural Hazard Credit Review," New York, NY, (August 26, 1986).

CHART 1

Competitive vs. Negotiated Sales

I. Comparison	Advantages	Disadvantages
A. Competitive	Public Auction Easy to Justify Bid Prices Broad Exposure to Purchasers No Favoritism	Inflexible Timing Unable to Structure Provisions of the Issue to Institutions' Requests Minimal Pre-Sale Support Risk Premium in Difficult Market
B. Negotiated	Good PreSale Awareness Flexible Timing Ability to Structure Issue for Certain Institutional Request Greater Planning Capacity	Price Justification Frequently Problematic Selection of Underwriter is Not Without Political and Other "Difficulty" Cost of Issuance and TIC Can Be Higher in "Normal"Market

II. When to Use	Competitive	Negotiated
	Issue is an Established Name Credit is Well Understood and Widely Accepted Non-Volatile Market Conditions Type of Issue is Not Unique	Issuer Has Not Previously Sold Debt Market Needs Education Regarding Disclosure is Routine Security and Credit Issuer Has Faced Well-Publicized Financial or Debt Problems Volatile Market Conditions Type of issue is Unique

NOTE:

BOTH SALES TECHNIQUES HAVE A ROLE IN DEBT MANAGEMENT OPTIONS, AND THE DISTRICT SHOULD CONSIDER THE ADVANTAGES/DISADVANTAGES OF BOTH IN THE FINAL APPROVAL OF ITS FINANCING PLAN.

CAPTIVA ISLAND EROSION PREVENTION DISTRICT
Table 1

FINANCING PLAN
OPTIONS SCORE MATRIX

Financing Option	Lease Cost	Legality	Revenue Adequacy	Equity	Public Acceptance	Ease of Admin	Totals
General Oblig. Bonds/ Notes	5	3	5	1	1	5	20
Spec. Assessment Bonds/ Notes	3	3	3	5	5	3	22
Certificates of Indebtedness	3	3	3	5	5	1	20
Pay As You Go	1	5	1	1	1	1	10

The Long Island Sound Study: an Overview including Public Participation and Education

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People in the United States are becoming increasingly aware of the effect the human population has on coastal waters and on the organisms that live in it. This paper describes the effort the Long Island Sound Study is making toward the clean-up and preservation of one of the most urbanized estuaries in the world. Long Island Sound is bordered by the populous areas of Connecticut and Long Island, New York. At its western end, the Sound is continuous with the New York Harbor/Hudson River system via the East River; at its eastern end, it is connected to the Atlantic Ocean by a narrow passage called "The Race."

The Long Island Sound Study is part of the National Estuary Program, which was established by Congress in 1985 based on successes in Chesapeake Bay and the Great Lakes. The program was formalized in the 1987 reauthorization of the Clean Water Act to protect estuaries of national significance. The program has rapidly expanded from the original four estuaries to twelve, and others are being considered for inclusion.

The U.S. Environmental Protection Agency administers the National Estuary Program, but each Estuary Program is managed slightly differently. The actual running of the Long Island Sound Study, including the distribution of funds, is a cooperative effort accomplished by a Management Committee whose members represent the federal, state and interstate agencies and institutions involved with the management of Long Island Sound. The Study is overseen by a Policy Committee made up of the Administrators of EPA Regions I and II (located in Boston and New York) and the Commissioners of the two state environmental departments (New York State Department of Environmental Conservation and Connecticut Department of Environmental Protection). The Management Committee is aided by two advisory committees: the Technical Advisory Committee, which addresses research and other technical issues, and the Citizens' Advisory Committee, which helps incorporate the public's concerns into the Study and helps provide information about the Study to the public.

The goals of the Long Island Sound Study are to 1) protect and improve the water quality of Long Island Sound and its coves and estuaries in order to ensure that a healthy and diverse marine community is maintained; 2) ensure that health risks associated with human consumption of shellfish and finfish are minimized; 3) ensure that opportunity for water contact recreation are maximized; and 4) ensure that social and economic benefits associated with the use of Long Island Sound are realized to the fullest extent possible by the citizens of Connecticut and New York. These goals are artless and non-controversial: to maintain the quality of the water so that the organisms will remain healthy and plentiful and so that people can continue to swim in, eat the fish and shellfish from and earn their living from the Sound. Because the Long Island Sound Study has only enough money to address some of of the many issues relevant to the health of Long Island Sound, the Policy Committee identified the most serious threats to attaining the goals of the Study. These are: 1) the deterioration of the Sound's living marine resources, 2) the effects of toxic chemicals and 3) the effects of low oxygen levels (hypoxia).

Research assessing the extent and causes of these problems has been carried out over the past three years. Now the major focus of the Study is the development of a hydrodynamic and water quality computer model of the environmental conditions in Long Island Sound. This model is due to be calibrated and verified during 1989. It will then be used to test the effectiveness of various management options, such as how the removal of a particular percentage of the nitrogen from all the sewage effluent entering the Sound will affect the level of oxygen found in the bottom waters of the western Sound during the summer. Finally, in 1991, the resulting recommendations will be included in the Comprehensive Conservation and Management Plan (CCMP). This document will serve as a guide for the agencies and organizations which are responsible for managing the Sound.

It has become increasingly evident that recommendations from government-sponsored studies are not implemented without broad- based public support. A public participation effort has been established in order to generate this support. The involvement of the public is one of the most important characteristics which sets the Long Island Sound Study apart from other studies. It is a complex task, requiring interfacing research-based information and public concerns.

There are Long Island Sound Study Public Participation Coordinators at both Connecticut and New York Sea Grant Marine Advisory Programs. The Marine Advisory Programs, which are the public outreach arms of the state Sea Grant Programs, are affiliated with their state Cooperative Extension Services. The Coordinators are responsible for disseminating information about the Study to the public and for eliciting the public's concerns and responses. To accomplish this large and important task, the Coordinators work closely with the Citizens' Advisory Committee (CAC).

This group of twenty-five people represent the various uses of Long Island Sound: conservation, education, business (including tourism), industry, real estate, sport and commercial fishing, boating and other recreational activities, and regional and local government. The CAC members also reflect the great geopolitical variation of the Sound's coast. With the support of the Management Committee, these volunteers have charged themselves with reviewing the products of the Study, putting on conferences and workshops and forming a speakers bureau. They also plan to work with legislators, particularly in light of the importance of environmental issues in recent election campaigns.

It has not been simple establishing a viable CAC and we may not yet be out of the woods. In order to remain interested, people must feel that they are performing a needed service. In 1986-87, the CAC experienced an attrition which left a core group of about six individuals. At that time, the focus of the Study was on the continuing research efforts and it is likely that the CAC members felt they had little to add.

This attrition might have been avoided if the CAC had been receiving training in public presentation techniques and in the history of pollution in Long Island Sound. A greater effort to provide them with the newest results of ongoing research may also have helped and they might have been asked to develop a strategy for public involvement which would be instituted when the focus of the Study shifts from research to management recommendations.

After becoming involved with the public participation project, Sea Grant helped the CAC expand their ranks to become more representative of the uses of Long Island Sound. The newly- active CAC then requested a New York Public Participation Coordinator and the Management Committee decided that it was important enough to fund with the Study's limited resources. In this manner, New York Sea Grant joined Connecticut Sea Grant in a cooperative effort. The CAC then adopted bylaws. The usual agenda of the CAC meetings has evolved into an informational presentation followed by reports from the subcommittees and a business meeting. The business of the CAC is the Committee's review of the direction the Study has taken or of the products the Study has produced.

Working with the CAC is one way the LISS Public Participation Project disseminates information about the Study to the public and elicits the public's concerns and responses. The Public Participation Coordinators are involved in various educational activities: editing a newsletter, *The LISS Update*; answering questions from individuals and working with the press; giving lectures, slide shows and television and radio presentations; putting on conferences and workshops; and bringing exhibits to expositions, such as the Eastern States Exposition and the New York Boat Show); producing fact sheets, posters and public service announcements; and compiling a list of organizations which will be the base of a network of people who will share information about the Study. These activities are attempts to educate the 14.6 million people who live in the watershed of the Sound about the Long Island Sound Study. During 1988, the Project's efforts to create a ground swell of interest in Long Island Sound recieved some unbidden help from series of beach closings which occured during the summer. These closings were generally caused by sewage spills or by fears regarding medical waste: the result of overreactions to reports of confirmed medical waste problems in New Jersey.

Since most implementation of the Study's recommendations will be done at the local or regional level, the Study's management and advisory committees agree that it is very important to involve local governments. The best mechanism for this is presently being evaluated. The Public Participation Project has been briefing legislators and has successfully run workshops for local officials. Several legislators have come out in favor of the Study. U.S. Congressman Joe DioGuardi (since unseated) has issued a statement which said, in part, "I am optimistic that the Sound can be protected and saved if we carry out the recommendations of the Long Island Sound Study."

There has recently been a great deal of political interest in environmental issues. A federal Long Island Sound caucus, comprised of the senators from New York, Connecticut and Rhode Island, has been formed. The members of a state level caucus were successful in getting signed into law in both Connecticut and New York the "Bi-State Long Island Sound Committee." The eighteen members of this committee (nine from each state) will report on the coordination and standardization of all laws relating to Long Island Sound and will make specific recommendations concerning the health of marine resources.

In spite of the successes, there is still much to be done to convince the people who live in the drainage basin of the Sound that if they care for the Sound they must take care of it. Our coastal resources are doomed unless the citizens of the country realize that the cost of dirty water is greater than the cost of keeping it clean. It is by working together toward the goals of the National Estuary Program that these valuable areas will continue to support fishing and swimming.

ELECTROSLAG SURFACING FOR CONSTRUCTION, RESTORATION, AND REPAIR OF SHIP STRUCTURES

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Abstract

With construction of new commercial ships in U.S. shipyards at an all-time low and Congressional appropriations insufficient to maintain a U.S. fleet of 600 ships, the priorities of the surviving U.S. shipyards are changing from that of shipbuilding to ship rebuilding, restoration and repair.

This paper presents a review of the international literature on the most recent developments in thick section surfacing by electroslag surfacing (ESS) using strip or wire electrodes. The advantages of this newly-developed technique from Japan are explained in comparison with the conventional surfacing processes, such as submerged arc surfacing (SAS). A number of innovations and applications in this area are introduced to emphasize the substantial economical advantage of strip ESS for ship repair and manufacturing.

ESS with strip electrodes is capable of overlaying a wide variety of corrosion and/or wear-resistant deposits on structural ship components with half the dilution level and twice the deposition rate of its closest competitor, SAS. Because of its significant economical merits, strip ESS has already become the dominant thick-section surfacing process in many industrialized countries, particularly in Japan, the Soviet Union and parts of Europe.

Nomenclature

ESS (Electroslag Surfacing); ESW (Electroslag Welding); SAS (Submerged Arc Surfacing)

Introduction

The future requirement for new ships forecast by the Association of West European Shipbuilders (Milne, 1987) implies over a third of the world's shipyard capacity active in 1985 will have to close if it is to be brought into line with demand. Unfortunately, international competition and foreign labor rates have put virtually all commercial shipbuilding contracts out of reach for U.S. shipbuilders (Thorell, 1986). This has created a fiercely competitive environment for the dwindling U.S. Naval contracts. With construction of new commercial ships in U.S. shipyards at an all-time low and Congressional appropriations insufficient to maintain a U.S. fleet of 600 ships (---Marine Log, 1988), the priorities of the surviving U.S. shipyards are changing from that of shipbuilding to that of ship rebuilding, restoration and repair.

Various surfacing processes have been utilized to repair and rebuild corroded or worn ship components. For many years, SAS with strip electrodes was considered the most cost-effective method to overlay large components, such as ship propeller shafts, and now still prevails in the United States. The Japanese and Soviet shipbuilders, in particular, have developed highly cost-effective methodologies to rebuild large ship components using an innovative concept known as "Electroslag Surfacing."

In 1980, Kawasaki Steel (Nakano, 1981 [a]) of Japan first developed a reliable strip ESS process, which rapidly spread throughout Japanese industries (---Welding Research Council, 1982). Several Western European countries also adopted this process and are commercially manufacturing standard ESS equipment (Forsburg, 1985).

The purpose of this study is to critically review the international literature on ESS and strip ESS. Of particular emphasis will be the flux chemistries and surfacing parameters that are associated with this processing innovation. The advantages of surfacing with the strip ESS method are reported.

Characteristics of Electroslag Surfacing

Although the strip ESS process is new, the fundamental principle of ESS is similar to that of the Electroslag Welding (ESW) process. Heat is generated by ohmic heating of a resistive slag by the passage of an electric current through a strip electrode, which is continuously fed into the molten slag pool. Figure 1 shows a schematic diagram of the ESS process. The process appearance of strip ESS is similar to that of strip SAS, except SAS is primarily arc-functioning while ESS is arcless and produces heat by I^2R (ohmic) heating of the molten slag.

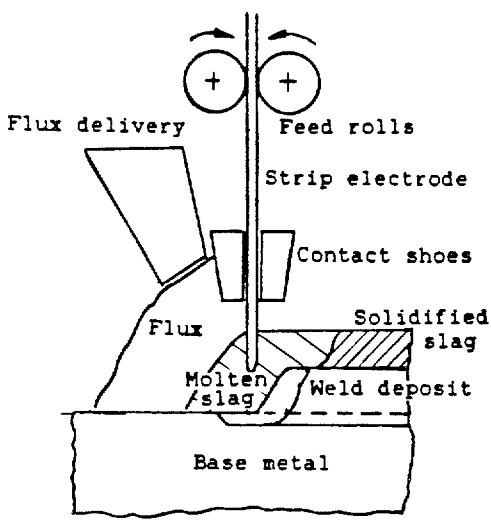

Figure 1. Diagram of the electroslag surfacing process.

The first important feature of strip ESS is low dilution in the deposits. In any surfacing process, a critical factor requiring precise control is the dilution ratio, expressed as:

$$\% \text{ Dilution} = B/(A + B) \times 100$$

where A is the cross sectional area of reinforcement of deposits above the base metal surface, and B is the cross sectional area of the melted base metal below the workpiece surface. In terms of surfacing, it is necessary to keep low dilution levels because the surfaced layer has to maintain its desired inherent properties, like wear or corrosion resistance. In SAS, the arc tends to penetrate more deeply and melt more base metal in comparison to ESS. For example, the strip SAS process typically produces a dilution ratio of 18% at a current density of 25 A/mm^2 (16.1 kA/in^2), compared to approximately a 9% dilution ratio for the strip ESS process at 41 A/mm^2 (26.5 kA/in^2) (---Oerlikon, 1985). Thus, the chemical composition of the overlay deposited by ESS will more closely resemble that of the filler metal. The second important feature of ESS is its high deposition rate, which is a function of the current density. The use of a high current density in the SAS process will effectively make the arc hotter and stiffer, thus causing it to penetrate more deeply into the workpiece to increase the dilution ratio. On the other hand, the strip ESS process allows the use of almost double the current density to produce a much higher deposition rate while still maintaining a lower dilution level. This desirable combination of a high deposition rate and a low base metal dilution was the main incentive for Japanese industries to eliminate SAS in favor of ESS.

The third important feature of ESS is the feasibility of single layer deposition. By virtue of its low dilution and high deposition rate, surfacing can be most economically attained for the desired thickness of a corrosion or wear resistant layer with a designed chemical composition. Since the dilution level for strip ESS is almost half that of strip SAS, the strip ESS process can more likely eliminate the necessity for multiple layer deposits and result in greater cost effectiveness. Furthermore, thin overlays (about 3 mm or 1/8 in. thick) are far more advanta- geous by ESS because dilution decreases with overlay thickness for ESS but increases by SAS.

Further economical advantage is gained by the use of wide strip which deposits a greater surface area per unit time. Large strip widths (60 mm [2.4 in.]) are particularly more difficult to apply by SAS than ESS. In the SAS process, the arc is struck at one corner of the strip and then starts traversing the entire width of the strip (Nakano, 1981 [a]). However, in ESS the strip is consumed uniformly across its entire width. The movement of the arc in SAS is not necessarily uniform and leads to inconsistent penetration and lack of fusion. For this reason, SAS has been limited to a strip width of 75 mm, whereas using strips as wide as 300 mm (11.8 in.) is not uncommon in ESS. A comparison between the strip ESS and SAS process is presented in Table I.

Table I. Comparison between submerged arc surfacing and electroslag surfacing with stainless steel strip electrodes (--- Oerlikon, 1985).

		SAS	ESS
Strip:	dimension (mm)	60 x 0.5	60 x 0.5
	carbon content (%)	0.015	0.015
Parameters:	I (A)	750	1250
	V (V)	26	24
	v (cm/min)	10	16
Current density (A/mm^2)		25	41.7
Heat input	(KJ/cm)	117	112.5
	(KJ/cm^2)	19.5	18.7
Bead thickness (mm)		4.5	4.5
Dilution (%)		18	9
Deposition rate (Kg/h)		14	22
Flux consumption		0.65	0.5
Carbon content of single deposit layer (metal base: 0.18% C)		0.045	0.030

Further Innovations in ESS from Japan

External magnetic field for ESS

In 1980, Nakano and his colleagues in Japan (Nakano, 1981 [a]) first developed an electromagnetic controlled strip ESS method called the MAGLAY process. During surfacing with wide strips (>60 mm [2.4 in.]), the formation of undercutting and lack of fusion defects were found to be related to the flow pattern of molten slag and metal, which is driven by the electromagnetic force induced by the high values of the surfacing current. Electric current, flowing parallel from the strip to the bottom of the molten pool, makes both slag and metal move from the edges of the pool toward the center. To counteract this force in the MAGLAY process, two direct current coils are mounted adjacent to the edges of the strip electrode resulting in counterbalancing magnetic forces. The use of an external magnetic field effectively (a) avoids undercut at the bead tie-ins, (b) eliminates slag entrapment, and (c) produces a more uniform thickness of overlay.

"PZ" arc-facilitating process

Strip surfacing at the Japan Steel Works also utilizes the electroslag mode of deposition but without the aid of magnetic devices (---Welding Research Council, 1982). Their process is called "PZ." The important feature of this process is that an arc is always maintained at the strip extremities while most of the strip tip is still in the electroslag mode. The auxiliary arc facilitates bead tie-in and penetration, but avoids excessive dilution at the center of the bead caused by the Lorentz force. The 150 mm (6 in.) wide strips used in the "PZ" process provide a uniform overlay surface and a low dilution level in each bead.

Innovations in the Soviet Union

Multi-strip feeding

The Paton Welding Institute started studies on ESS with two electrode strips in the late 1970's (Mastenko, 1982; Mastenko, 1984; Blaskovic, 1986). The advantage of this dual strip feeding process is a substantial increase in deposition rate. When two strips are fed in parallel, the molten slag may rise between the two strip electrodes and directly contact with air, causing considerable convectional agitation. Thus, the distance between two strips has become another important parameter to be taken into account.

Shvartser (Shvartser, 1981) claimed two hardfacing processes with a group of plate electrodes. In one case, the high Mn steel electrodes were deposited on worn dredger buckets. In another case, the high Cr casting iron electrodes were deposited on worn steel blades. The absence of cracks and formation defects made it possible to greatly increase the service durability of hardfaced components and reduce the production cost in comparison with brazing expensive alloy.

Surfacing of shaped parts

A variety of examples could be found in the Soviet technical journals, reporting the use of ESS for the restoration of worn components having complex shapes. The surfacing of those shaped parts is performed by a modified electroslag welding process. A specially designed water-cooled mold is used to confine the molten slag and metal pool into the desired shape (Valits, 1981). To restore a complicated shape, the energy of the melt must be sufficient to ensure both the transfer of the melt to the remote part of the mold and the complete fusion at that location. Figure 2 illustrates the use of a shaped mold for surfacing the teeth of excavator buckets.

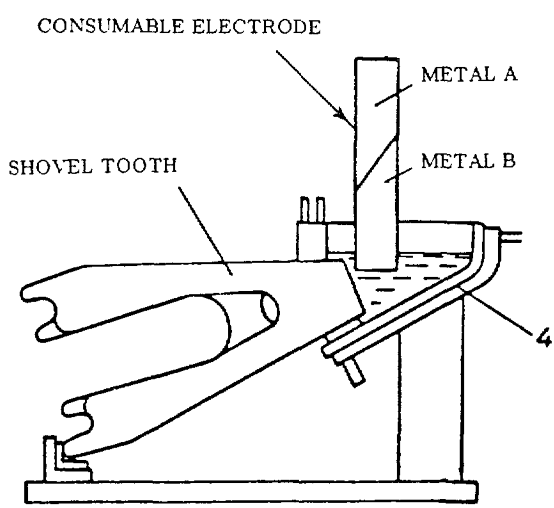

Figure 2. Diagram illustrating the ESS of an excavator shovel tooth with varying chemical composition metal.

Surfacing of thin-walled components

A report from the Tashkent Institute of Railway Transport Engineers claimed the development of a successful example for the ESS of the friction wedge of the damper of wagons whose maximum wall thickness was only 5 to 6 mm (~0.2 in.) (Ashkinazi, 1986). In this process, nine electrode wires (each 3 mm [1/8 in.] in diameter) are deposited simultaneously. The main parameters of this process include: 32 volts, an electrode feed rate of 0.51 m/hr (20 in/hr), and a surfacing speed of 1.8 m/hr (70 in/hr). A few factors are critical to prevent burn-through defects, including the slag pool depth, the electrode extension, and the stationary (without longitudinal displacement) feeding time of electrodes in the initial stage of surfacing for inducing the slag pool and the final stage of surfacing for filling the crater. By increasing the initial stationary feed time, the molten filler metal spread ahead of the electrode tip thermally protecting the base metal. A wear-resistant layer of 6-12 mm (0.24-0.47 in.) thick and 135 x 180 mm (5.3 x 7 in.) in size is reported being deposited in a single pass on the surface of mild steel.

Surfacing layers with compositional gradients

In many cases of service, the different portions of an individual hard-faced work piece experience different degrees of wear. The geometrical loss due to the uneven wear reduces its life prematurely. The rational solution to this problem is to make the working surface from composite metal, whose wear resistance changes gradually to accommodate the differences in the severity of wear at different locations on the workpiece. By producing a part that wears uniformly, the functional life of the part is lengthened.

Shvartser (Shvartser, 1980; Shvartser, 1985) developed a special surfacing process to provide a wear gradient for an excavator shovel, which is illustrated in Figure 2. In service, the abrasive wear on its rear face increased substantially from the tail end of a tooth to its apex. In order to extend its life, a prescribed variation in chemical composition of the deposited metal was obtained by depositing a special composite electrode which consisted of two dissimilar metals (a high Mn steel and a high chromium iron) meeting along an inclined plane. The surfacing deposits adjacent to the front face of the teeth were a wear-resistant Cr iron, changing (towards the rear face) into a high Mn steel. In service, those hardfaced teeth maintained a consistent geometry.

Process Details

Power source

ESS is always carried out with direct current, constant voltage (DC-CV) power sources using reversed polarity (the strip electrode is connected to the positive terminal of the power source) in order to ensure adequate fusion to the base metal. Since the optimal current density for ESS is around 40 A/mm^2, the output rate of power sources at a 100% duty cycle should meet the following minimum load handling requirements: 1250A for 60 x 0.5 mm (2.4 x 0.02 in.) strips; 1800A for 90 x 0.5 mm (3.5 x 0.02 in.) strips; and 2400A for 120 x 0.5 mm (4.7 x 0.02 in.) strips (---Oerlikon, 1985).

Flux chemistry

Hn strip ESS, it is very critical to establish stable ohmic (arcless) conduction of electricity through a shallow slag pool. Fluxes must provide greater electrical conductivity than would be needed for normal electroslag welding of the same plate material. Adding large quantities of fluorides, mainly CaF_2 and NaF and/or semiconductors, such as TiO_2 and FeO, can greatly raise the electrical conductivity of molten slag without risk of generating arcs. However, large quantities of TiO_2 in slag cause a deterioration in the detachability of the slag. Therefore, additions of fluorides are more preferable (Nakano, 1981 [a]; --- Oerlikon, 1985).

The level of electrical conductivity of slag is closely related to the fluoride content in the flux, as illustrated in Figure 3. The IIW (International Institute of Welding) Document XII-A-4-81 (Nakano, 1981 [b]) indicated that in the $3CaO$-$3SiO_2$-Al_2O_3 ternary system, when the fluorides were less than 40% (balance ternary), the submerged-arc mode prevailed; and when more than 50% fluorides, the electroslag mode prevailed. In terms of the electrical conductivity of the slag, this corresponded to a transition range of 2 to $3\Omega^{-1}$ cm^{-1}. Above $3\Omega^{-1}$ cm^{-1}, a stable electroslag mode is easily achieved. However, to restrict the generation of fluoride type gases (due to a reaction: $2CaF_2 + SiO_2 \rightarrow 2CaO + SiF_4$), additions of CaF_2 were usually held at slightly less than 50%.

In Japan, fluxes for stainless steel overlays are principally supplied by Kawasaki Steel and Kobe Steel (---Welding Research Council, 1982). The Kawasaki KFS-150 is a fused flux with an electrical conductivity of about $3\Omega^{-1}$ cm^{-1} at 1700°C. The composition of Kawasaki's patented flux (Tatershi, 1984) contains 50-60% CaF_2, 10-20% SiO_2, 5-25% CaO and 10-30% Al_2O_3 in a ratio of SiO_2/CaF_2 of at least 0.20 and a ratio of CaO/SiO_2 of at least 0.50.

In the Soviet Union, a series of fluxes were developed for ESS. The ANF series fluxes are of high fluoride contents (50%) and high electrical conductivities (Paton,

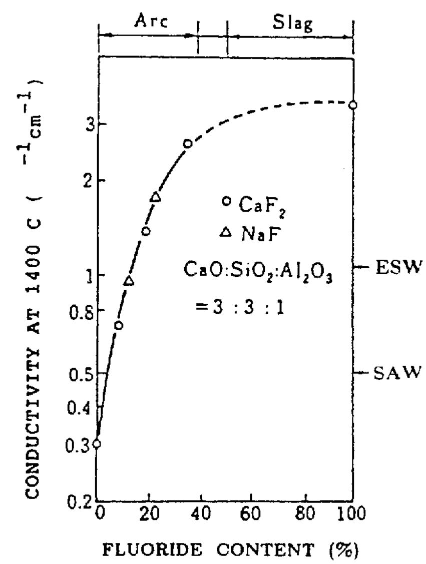

Figure 3. Effect of fluoridecontent in flux on electrical conductivity and current conduction type during Strip ESS (Nakano, 1981 [b]).

1983). The AN-series fluxes, which were originally used in ESW, are also used for the thick layer build-up. Their fluoride contents are below 25% and electrical conductivities are comparatively low. Some new fluxes were occasionally reported being developed for certain special ESS processes. However, no concrete compositional information was presented.

In Western Europe, fluxes EST 122 and 201 are commonly used (--- Oerlikon, 1985). The flux EST 122 is specifically designed to be used for the deposition of all types of stainless steel strips. The flux EST 201 is designed for the deposition of the Ni-base alloys, such as 825, 600, 625 and 400 (Forsburg, 1985).

In a recent study (Yu, 1987) of ESS with stainless steel wire electrodes, fluxes of the CaF_2-CaO-Al_2O_3 system were studied. It was noticed that at higher CaF_2 percentages, (i.e. beyond 70%), the process was once again that of arc conduction. As the percentage of the CaF_2 in the flux increased, there was a corresponding increase in the conductivity level. This, in effect, raised the current at the same wire feed speed, and gave rise to burn back problems. Hence, at higher CaF_2 percentages, arcing could be visible on the surface of the molten slag. On the other hand, below 40% CaF_2, the observed arcing noticed was the submerged-arc type.

Usually, CaO, SiO_2 and Al_2O_3 are common additions for optimizing the conductivity level of a CaF_2-based flux. The practice at the Oregon Graduate Center (Yu, 1987) indicated that optimizing the viscosity level of molten flux is of the same importance. Since conductivity and viscosity have an inverse relationship, adjusting the flux composition becomes a complex problem. SiO_2 is one compound which has a major influence on slag viscosity and slag flow (Tatershi, 1984). To maintain the desired viscosity, it is necessary to control a SiO_2/CaF_2 ratio of at least 0.2 and to avoid evolution of toxic gases like SiF_4. In addition, the minimum requirement for CaO/SiO_2 ratio should be about 0.5 for stable ESS.

Strip electrode sizes

The thickness of the strip electrode is always expected to be thin enough to facilitate coiling into rolls, in order to conveniently feed cladding during ESS. The Japanese appear to have standardized the 0.4 mm (0.016 in.) thickness for all strip widths. This differs from the European practice where a 0.5 mm (0.02 in.) thickness is most common. The ESS process favors the use of wide strip as long as the capacity of the power supply is adequate to provide 1000-2000 amps, typically. That is because, at a given layer thickness, the most marked effect of increasing the strip width is a decrease in dilution and penetration (--- Oerlikon, 1985).

Voltage

Voltage is perhaps the most critical controlling parameter in the ESS process. In most ESS practice, the working range of voltage values is quite narrow, because of the shallow depth of the molten slag pool (5-10 mm [0.2-0.4 in]). For a fluoride-based flux, the stable range is usually 26-28 volts (Forsburg, 1985). When the voltage is below 24 volts, it is difficult to initiate the process, and the strip tends to stick to the base metal resulting in short circuiting. On the other hand, above 28 volts, the process starts arcing on the surface of the flux, and slag spatter becomes violent. Therefore, an accurate control in voltage is extremely important.

Yu, et al. (Yu, 1987) found that the optimum voltage was closely related to the actual depth of the molten slag pool, and a stable ESS process could be performed at 22-24 volts. In addition, it was also shown (Yu, 1987) that an intentionally increased open-circuit voltage is beneficial to the initiation of ESS. Even within the stable voltage range, fluctuations in voltage also affect the penetration and geometry of the surfacing layer. Nevertheless, the dilution level still remains essentially constant or only slightly decreases with increasing voltage.

Current

ESS has been reportedly used (Forsburg, 1985) only with DC reverse polarity (electrode positive). At a given voltage and surfacing speed, increasing the ESS current directly increases penetration, bead width and thickness, but has little effect on dilution. Stable and quiet welding conditions can be achieved within a given range of ESS current. The optimum current density for strip ESS is around 40 A/mm^2 (26-29 kA/in^2). At the higher values of current density, the amount of slag spatter increases and the depth of the slag pool has to be raised to stablize the operation.

Travel speed

At a given welding current and voltage, increasing the travel speed tends to increase dilution and penetration, while decreasing bead width and thickness (Forsburg, 1985). Increasing the travel speed in effect reduces the heat input and, thereby, decreases the electrical conductivity of slag. The ESS process can only be stable when sufficient contact area between the molten slag pool and the melting strip is maintained. An excessively fast surfacing speed may cause the strip to be in contact with cold flux or insufficiently heated slag, thus resulting in sporadic arcing and process instability.

Excessive travel speed results in not only a bead thickness less than 4 mm, but also in the risk of the formation of undercutting. On the other hand, too slow a travel speed results in a bead thickness above 6 mm. Then, the wetting angles of beads become too steep and slag entrapment may occur at the overlaps. In general, the optimum travel speed range is about 160-200 mm/min (6-8 in/min), which results in about a 10% dilution level, and consumes about 0.15 kJ/mm^2 (96 kJ/in^2) heat input (Yu, 1987).

Applications of Strip ESS

Presently, strip ESS is entirely foreign technology, which has further widened the construction cost gap between the Asian shipyards and U.S. shipbuilders. However, utilization of this foreign technology and the substantial improvements in strip ESS anticipated at the Oregon Graduate Center will enhance the economic position of U.S. shipyards to rebuild worn, eroded or redesigned structural ship components, such as large propeller shafts, rudder horns, strut shafts, deeply corroded portions of the hull, hawse pipes and leading edges of rudder castings.

This process, though fully automatic, is also portable in the shipyard when a conventional (and inexpensive) carriage system is used to mobilize the strip ESS system in remote locations. A typical carriage system can handle 1500 amps and can pull power cables 30 m (100 ft.) long while being either track or manually guided. These carriage systems have been commercially manufactured in the United States for many years for submerged arc welding applications, particularly in shipyards.

Conclusions

Based on a computerized search of the international technical journals on the subject of electroslag surfacing, a critical review was performed and the following can be concluded:

1. ESS with strip electrodes is the most economical and productive method to overlay a wide variety of corrosion and/or wear resistant deposits on structural ship components, such as propeller shafts.
2. The highest deposition rates combined with the lowest base metal dilution are characteristic of ESS with strip electrodes compared to conventional surfacing methods, such as strip SAS, GMAW and SMAW.
3. The dominant thick-section surfacing process in Japan, the Soviet Union and several European countries is ESS.
4. Neither U.S. shipyards nor U.S. manufacturing industries have adopted the ESS process. Conventional surfacing methods are still utilized in the U.S.
5. Technically, the key difference between the newly-developed ESS process and other similar processes, such as SAS and ESW, is the flux chemistry.

Acknowledgment

The authors are grateful to the U.S. National Coastal Research Institute for financial support under Contract 51-01-38R0-D. The authors wish to thank Mr. Tom J. Maginnes and Dr. Earle N. Buckley of NCRI for their helpful advice. Also, the assistance of Mr. Sin-Jang Chen is appreciated.

References

---, "600 Ship Navy Won't be Sustained," Marine Log, January, 1988, pp 49-51.

---, "Electroslag Strip Cladding"--A draft, Oerlikon Industries, (1985).

---, "Welding Technology in Japan," Welding Research Council, N.Y., (1982), p 16-22.

Ashkinazi, E. and E. Sheinmass, "Factors Affecting the Quality of Bonding in Wide-Layer Surfacing of Thin-Walled Components," Welding Production, Feb. 1986, p 24.

Blaskovic, P., S. Lesnak and J. Zajac, "Electroslag Surfacing in the Horizontal Position Using Two Strip Electrodes," Surfacing J. Int. 1, (2), (1986), pp 75-78.

Forsburg, S., "Resistance Electroslag (RES) Surfacing," Welding Journal, August 1985, p 41.

Mastenko, V., E. Starchenko and V. Khodakov, "Stability of The Electroslag Process in Two Electrode Strip Surfacing," Welding Production, March, (1982), p 23.

Mastenko, V. and E. Starchenko, "Effects of Variation in Welding Parameters on Weld Surfacing With Two Strip Electrodes," Automatic Welding, July 1984, p 50.

Milne, P. A., "High Technology in Shipbuilding," Proc. Inst. of Mech. Engrs., Vol. 201, No. B2, 1987, pp 59-72.

Nakano, S., N. Nishiyama, T. Hiro and J. Tsuboi, "Maglay Process- Electro-Magnetic Controlled Overlay Welding Process with ESW," Kawasaki Steel Technical Report, No. 2, March (1981), p 31. [a]

Nakano, S., T. Hiro, N. Nishiyama and J. Tsuboi, "The New Strip Electroslag Overlay Technique with Electro-Magnetic Control--The Maglay," IIW Document, XII-A-4-81, (1981). [b]

Paton, B., (ed.), "Electroslag Welding & Surfacing," Vol.1, MIR Publishers, Moscow, (1983), p 172.

Shvartser, A., V. Shvarts and Z. Nikitenko, "Calculating the Amounts of Components in a Varying Chemical Composition Alloy During Electroslag Surfacing," Automatic Welding, Feb. 1980, p 17.

Shvartser, A., "The ESS of Components With a Group of Electrodes," Welding Production, Jan. 1981, p 27.

Shvartser, A., V. Stoiko, Z. Nikitenko and I. Morgachev, "Excavator Shovel Teeth Reconditioned by Surfacing with Varying Composition Metal," Automatic Welding, March 1985, p 43.

Tatershi, J., T. Ishikawa, S. Nakano and N. Nishiyama, United States Patent 4,437,406, (1984).

Thorell, L. M. and T. Watanabe, "Technical Collaboration Between Mitsubishi Heavy Industries and Todd Shipyards," in the Proceedings of the National Shipbuilding Research Program, 1986 Ship Production Symposium, Paper No. 5, Sponsored by SNAME Ship Production Committee, 1986.

Valits, K., A. Shvartser, V. Dorokhov and B. Matveev, "The Effect of the Conditions of ESS of the Quality of the Deposited Layer," Welding Production, May 1981, p 26.

Valits, K., A. Shvartser and V. Stoiko, "A Flux For Electroslag Hard-facing of High-Manganese Steel," Adv. Spec. Electrometall., Vol. 1, No. 4, (1985), pp 162-165.

Yu, D., Y. K. Oh and J. Devletian, Unpublished research, Oregon Graduate Center, (1987).

DESIGN FOR OPTIMUM BREAKWATER CONFIGURATION AT FISHERMAN'S WHARF, SAN FRANCISCO BAY, CALIFORNIA

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Introduction

The Fisherman's Wharf area is located in San Francisco Bay near the Golden Gate (Figure 1) and is a well-defined segment of the San Francisco City waterfront.

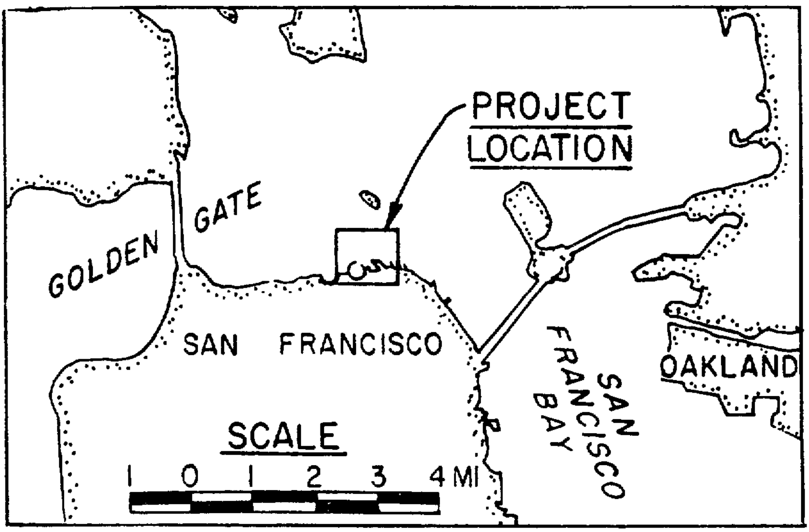

Figure 1. Project location.

The area is bounded on the east by Pier 45 and on the west by the Municipal Pier. Existing development consists of a complex of commercial and recreational facilities. For many years Fisherman's Wharf has been the center of the northern California commercial fishing industry. Data from the California Department of Fish and Game indicates that about 16.8 million pounds of fish were landed at Fisherman's Wharf in 1979 and the amount is increasing by about one million pounds annually (US Army Engineer District, San Francisco, 1982). About 170 berths are located in the area for commercial fishing boats. The Fisherman's Wharf area is a world famous tourist attraction with a complex of recreational activities that receives in the tens of millions of visitors annually. The San Francisco Maritime State Historic Park is located on the Hyde Street Pier where five historic antique ships are on display to the public. Custody of this historic fleet has been transferred to the Golden Gate National Recreation Area. Excursion vessels provide waterfront tours of the area. Sport fishing is popular, and numerous boats engage in regular for-hire trips. The area encompasses many commercial businesses, including curio shops, restaurants, parks, sidewalk cafes, fishing shops, hotels, marinas, museums, and shopping complexes, clustered about the central attraction of the Wharf and its commercial fishing activities.

Although part of a densely developed, heavily populated area with a network of piers, wharves, and berthing areas, Fisherman's Wharf is essentially unprotected from wave damage. Minimal protection provided by timber piers has diminished with the removal of deteriorated sections. During winter storms, wave energy from the open ocean (entering through Golden Gate) and local storms (waves generated by winds across the extensive water surface of the bay), result in continual damage to fishing vessels and mooring facilities. Many fishermen have abandoned the harbor due to recurring boat damage. Waves also have caused damages to the historic vessels berthed in the area. Wave activity is relatively mild compared with the open coastline, but Fisherman's Wharf is the most exposed and vulnerable of small-craft harbors within San Francisco Bay with wave heights ranging up to 5.5 ft in the area (Assistant Secretary of the Army, 1983). Recreational berthing within the city of San Francisco is limited with only about 700 berths available, all of which are occupied. Improvement at Fisherman's Wharf could provide additional recreational facilities to meet the increasing demand for such in the area.

The Coastal Engineering Research Center (CERC) has completed physical and numerical model investigations to determine (1) the most economical breakwater configuration that would provide adequate wave protection for craft in the area from short-period waves, (2) the impact of reflections from the proposed breakwater with regard to erosion of the beach at Aquatic Park, (3) the impact of the proposed structure with regard to harbor response due to wave excitation for long period wave energy entering through the Golden Gate, and (4) the impact of the proposed breakwater on the motions of the historic vessels moored along or near the Hyde Street Pier.

The Physical Model

The physical model was constructed to an undistorted linear scale of 1:75, model to prototype and operated in accordance with Froude's model law (Stevens et al, 1942). It reproduced the entire Fisherman's Wharf area (Figure 2), which included approximately 6,400 ft of the San Francisco Bay shoreline that extended from a point east of Pier 45 to a point west of the Municipal Pier, and underwater contours in the bay to an offshore depth of 60 ft. The total area reproduced in the model was approximately 6,000 sq ft which represents about 1.1 sq miles of the prototype. Test waves with periods ranging from 3 to 10 seconds and heights ranging from 2 to 5.8 ft were generated by a 40-ft-long wave generator from six test directions. Resistance-type wave gages and an automated data acquisition and control system were used to secure wave height data at selected locations in the model, and a coal tracer material was used to qualitatively determine the movement of sediment in Aquatic Park. Still-water levels of 0.0 and +5.7 ft were selected for use during model testing. The lower value (0.0 ft) represents mean lower low water (mllw) and the higher value (+5.7 ft) represents mean higher high water.

Prior to testing of various improvement plans, comprehensive tests were con-

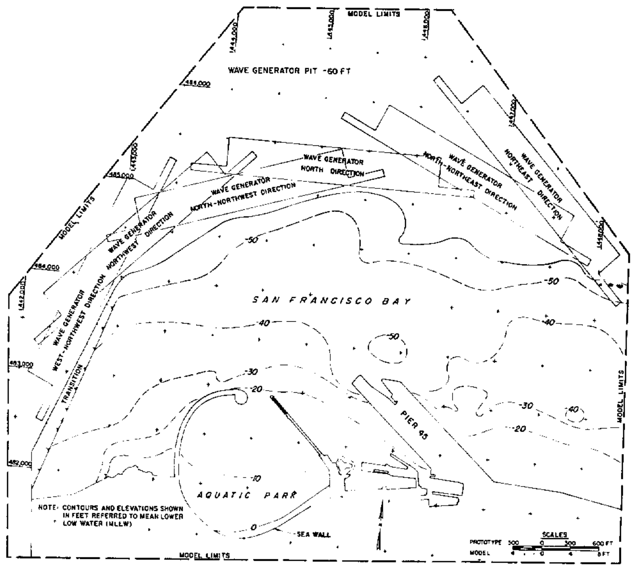

Figure 2. Model layout.

ducted for existing conditions to establish a base from which to evaluate the breakwater plans. Wave heights, sediment tracer patterns, wave pattern photographs, and videotape footage were obtained for test waves from all six test directions. Wave height tests indicated rough and turbulent wave conditions in the various mooring areas of the harbor for storm waves from all test directions. The harbor is virtually unprotected and wave heights were obtained in excess of 4 ft in the proposed small-craft harbor area, in excess of 3 ft in the existing fishing boat mooring area, and in excess of 5 ft along Hyde Street Pier in the historical vessel mooring area. Sediment movement in Aquatic Park for existing conditions was typical of a pocket beach. Material moved in both directions (east and west) depending on the incident wave direction with no material leaving the system.

The originally proposed breakwater plan consisted of a 1450-ft- long curved solid breakwater enclosing the area between Hyde Street Pier and Pier 45. A 385-ft-long baffled breakwater was also attached to the center of Pier 45 at its bayward end. Tests revealed excessive wave heights in the proposed small-craft mooring area (wave heights in excess of 4.5 ft) and in the historic vessel mooring area (wave heights in excess of 3 ft). For an improvement plant to be acceptable, the U.S. Army Engineer Districts of Los Angeles and San Francisco specified that, maximum waveheights in the small-craft and fishing vessel mooring areas should not exceed 1.0 ft; and maximum wave heights in the mooring area provided for the historic fleet should not exceed 1.5 ft.

Model tests were conducted for 90 test-plan variations which consisted of changes in the lengths, alignment, and locations of solid, baffled, and/or segmented breakwater structures. The optimum improvement plan, considering wave protection afforded the harbor and entrance, ease of navigation, and economics, consisted of a 1,560-ft-long outer solid breakwater configuration with a 150-ft-long segmented breakwater (28-ftsolid sections and 6-ft openings) installed diagonally between the fingersof the bayward end of Pier 45 and a 250-ft-long segmented breakwater installed adjacent to the west side of the west finger of Pier 45. Coal tracer tests indicated that reflections off the new outer breakwater would not result in adverse impacts on sediment (such as beach erosion) in the Aquatic Park area.

Harbor Oscillation Study

To study harbor response to long-period wave energy a numerical model was utilized. The model used a hybrid finite element solution to the generalized Helmholtz equation in shallow water. It has been applied successfully to several study areas by CERC and has been expanded to incorporate variable depth bathymetry and the dispersion relationship from linear wave theory. The effects of bottom friction and boundary absorption on harbor resonant response also has been incorporated recently into the model (Chen, 1986) which more accurately reproduces the conditions seen in prototype data and physical model testing.

Harbor oscillation tests were conducted for existing conditions and the optimum breakwater plan (as determined in the physical model) for wave periods ranging from 30 to 600 seconds. Frequency response curves, contours of wave height amplification, and vector plots of normalized maximum current velocities were obtained for both conditions. The finite element grid used for the improvement plan is shown in Figure 3.

Frequency response curves of wave height amplification identified resonant peaks for existing conditions at 34.5-, 54-, 79.5-, 115.5-, 135-, and 228-sec wave periods and for the breakwater plan at 63-, 81-, 115.5-, 147-, and 228-sec wave periods. Prototype long-period wave data at the site indicated that long-period wave energy was generally present at periods greater than 171 sec and that possible modes of oscillation for periods less than 171 sec did not develop. Based on the results of the harbor oscillation evaluation, the optimum breakwater plan (developed in the physical model) will result in decreased (15 to 20 percent) wave height amplification in the inner harbor area when compared to existing conditions.

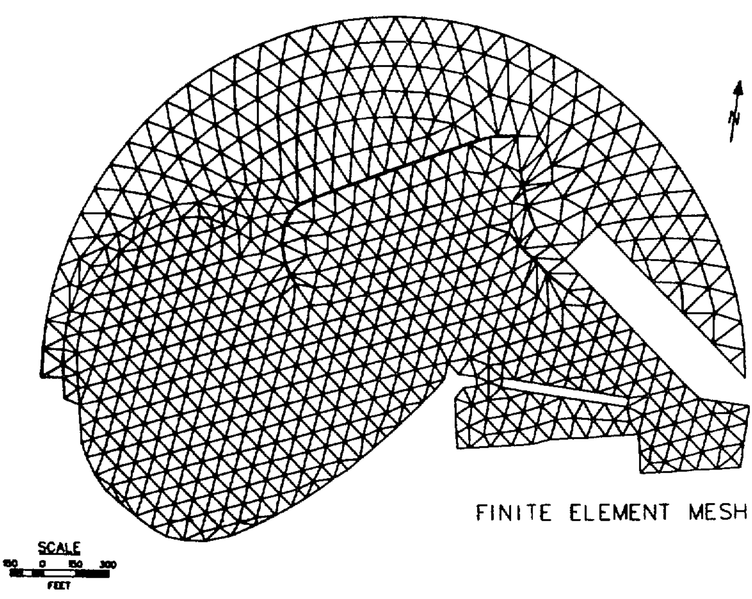

Figure 3. Finite element grid.

Ship Mooring Analysis

A ship mooring analysis was conducted for the historic fleet to determine conditions under which significant long-period ship motions could occur, and the effect of the proposed breakwater on the motions of the vessels. Within the Fisherman's Wharf area, the historic fleet is moored on either side of Hyde Street Pier. The fleet consists of five vessels, at present: the C.A. Thayer, Eureka, Hercules, Eppleton Hall, and Alma which are either listed or nominated for inclusion on the "National Register of Historic Places." On several occasions significant ship motions have caused anchor lines to move and mooring lines to part which has resulted in damage to ships and piers. Mooring locations along the Hyde Street Pier are shown in Figure 4.

The ship mooring numerical model used in this study can be used with limited ship characteristic data and has the ability to incorporate geometric asymmetries and nonlinear elastic properties of the mooring system (Raichlen, 1968). In the model, the ship is idealized as a block body positioned in a standing wave field (linear wave theory is used), and the bow- to-stern axis of the vessel is perpendicular to the nodal lines. Thus, the motion considered in the analysis is the surging (horizontal motion) in the bow-to-stern direction. The standing wave acts as the

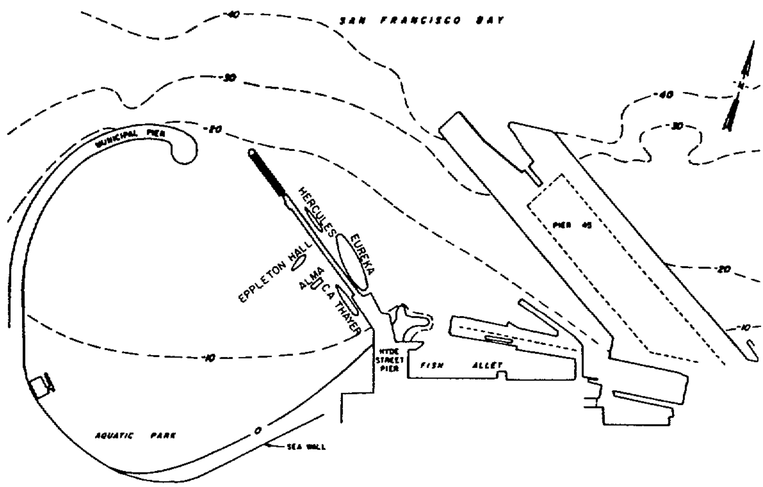

Figure 4. Historic fleet mooring locations.

dynamic force moving the ship from equilibrium while the lines counteract this motion and act as a restoring force that holds the vessel in dynamic equilibrium.

Results of ship motion analysis indicated that the proposed breakwater plan would substantially reduce ship response along the Hyde Street Pier for short-period waves. For long-period wave activity, it was determined that the breakwater plan will not result in significantly changed ship mooring conditions.

Discussion

Through the joint applications of physical and numerical models, an optimum breakwater configuration at Fisherman's Wharf was selected (with regard to short-period wave protection, harbor resonance due to long-period wave energy, and ship motions of the historic fleet). Construction of the recommended breakwater plan was completed in 1986 Wave conditions within the harbor have been very calm, even during periods of storm wave attack, and the harbor has performed as intended to this point.

Acknowledgment

The Office, Chief of Engineers, USAE, is gratefully acknowledged for authorizing publication of this paper. The experimental tests and the data presented herein, unless otherwise noted, were obtained from studies sponsored by the US Army Engineer District, San Francisco.

References

Assistant Secretary of the Army (Civil Works), 1983 (Oct). "San Francisco Harbor, California, Fisherman's Wharf Area," Report from the Chief of Engineers, Department of the Army, Washington, DC.

Chen, H. S., 1986 (Apr). "Effects of Bottom Friction and Boundary Absorption on Water Wave Scattering," *Applied Ocean Research*, Vol. 8, No. 2, pp. 99-104, An International Journal from Computational Mechanics Publications, Southampton, England.

Raichlen, R., 1968 (Aug). "Motions of Small Boats Moored in Standing Waves," Contract Report H-68-2, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Stevens, J. C., et al., 1942 (Jul). "Hydraulic Models," Manuals of Engineering Practice, No. 25, American Society of Civil Engineers, New York, NY.

US Army Engineer District, San Francisco, 1982 (May). "Fisherman's Wharf Area, San Francisco Harbor, California," Information Pamphlet, General Design Conference, San Francisco, CA.

The CSS FCG SMITH—A New and Unique Vessel for the Canadian Hydrographic Service

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Introduction

The primary mandate of the Canadian Hydrographic Service (CHS) is the charting of Canada's navigable waters. The CHS is divided into four regions—Scotia Fundy, Quebec, Central and Arctic, and Pacific—with the headquarters unit located in Ottawa, Ontario. Many of the survey vessels in the Department of Fisheries and Oceans' fleet are well past their mid life expectancy and rapidly approaching obsolescence. The long term goal is to systematically replace the aging vessels with ones that are modern and efficient. One facet of this goal is to equip the new survey vessels with state of the art survey equipment to ensure that CHS will be able to effectively carry out its mandate.

The pressure for the construction of one of the Department's newest vessels, the CSS FCG SMITH has come, in part, from the dramatic evolution in the shipping industry that has taken place over the past few decades. Ships are becoming larger and operational considerations are placing more and more economic pressures on both owners and masters to navigate with decreasing margins of underkeel clearance. Modern technology has also significantly increased the ease and accuracy with which a vessel can be navigated. These changes have, in turn, placed increased demands on CHS to carry out more surveys of Canadian ports with greater detail and accuracy. There are more than 2000 ports and harbors on the Eastern Coast of Canada. Since CHS is liable for the accuracy of its charts, it is vital that they are correct and up to date.

In order to respond to the demands, the Department of Fisheries and Oceans commenced, through the Federal Government's Department of Supply and Services, the procurement process for the acquisition of a new survey vessel during the spring of 1984. This vessel was to be used primarily for 100% bottom coverage surveys of ports, harbor approaches, dredged channels and anchorages. The CSS FCG SMITH, a 34.8 metre catamaran, was commissioned on April 25th 1986, and went into service during the following May, carrying out hydrographic surveys of ports and harbors on Canada's East Coast.

Historical Overview

CHS first investigated the use of sweep systems for improving the coverage, accuracy, and productivity of surveys as early as the mid sixties [Burke, 1984]. A Raytheon 719 Channel Sweep System was acquired during the early seventies; however, this system was never put into operational use. The latter part of the seventies saw a major explosion in the level of hydrocarbon exploration in the Canadian

Arctic. This dramatic and rapid increase in exploration also placed significant pressures for production and transportation of hydrocarbon products in a region where charting is, in many instances, substandard or nonexistent.

Funding for CHS's first sweep system came from Transport Canada's Arctic Marine Transportation Research and Development Program. The objective of the Arctic Sweep Project was to develop a transportable sweep system suitable for Arctic deployment. Operational requirements dictated that the system be configured in a manner that would allow for its transportation in a small aircraft such as the Twin Otter and that it be deployable from a "small vessel of opportunity" (10 metres or less) without requiring extensive modifications to that vessel.

An 18 channel Navitronic Seadig 201 Channel Sweep System was acquired during the spring of 1983. A floating boom mechanism was fabricated at the Bedford Institute of Oceanography to provide a deployment platform for the 18 transducers. Data processing was carried out on a HP 1000 Computer System using a software package written by CHS staff. The system saw extensive use in many East Coast Canadian ports and harbors and was successfully deployed on a survey in the high Arctic near Grise Fjord, Ellesmere Island. Experience gained with the system proved very valuable in the introduction of the CSS FCG SMITH.

The CSS FCG SMITH

The CSS FCG SMITH is named after Frank Clifford Goulding Smith who served as Dominion Hydrographer of CHS from 1952 until 1957. The principal particulars of the vessel are as listed:

Length overall	34.8 metres
Length at waterline	32.8 metres
Breadth	14.0 metres
Breadth-Single hull	4.0 metres
Breadth-Moulded	3.4 metres
Draft (design)	1.9 metres
Swath Coverage (at a depth of 15 metres)	43.7 metres
Displacement	328.0 tonnes
Trial speed	12.0 knots
Shaft horsepower @1800 rpm	2 x 400 hp
Crew	11
Classification	Lloyds +100A1 East Coast of Canada Home Trade II

The ship is equipped with the most modern navigation and communications equipment. In addition, the automated engine room is controlled and monitored from the bridge. Figure 1 shows the general arrangement diagram of the vessel. Evans, Yeatman and Endal Associates Ltd. of Dartmouth, Nova Scotia is the naval architectural firm that designed the catamaran. Georgetown Shipyards of Prince Edward Island constructed the vessel and Canada Dredge and Dock Co. Ltd. of Toronto, Ontario designed and fabricated the boom system for deploying the array of transducers.

A catamaran design was chosen because of its inherent stability over that of a conventional monohull. During the conceptual design stages a SWATH hull was considered. The final selection was dictated by budgetary considerations and the fact that the vast majority of surveys would be carried out in sheltered waters.

One of the most difficult design challenges was in the selection of a mechanism for the deployment of an evenly spaced array of 33 transducers. Several systems in both Europe and North America were closely examined. In the analysis of boom mechanisms, careful consideration was given to deploying the transducers from submerged hydrofoil booms or from booms above the water surface with the transducers on the end of downward projecting "break away" struts. The submerged booms, while providing a degree of stability to the survey vessel, were found to be more costly to construct and more difficult for transducer replacement. This type of boom is normally oil filled and presents a potential pollution hazard in the event of damage.

The mechanism for the deployment of the 33 transducers is comprised of 3 subassemblies. Two of the subassemblies consist of a port and a starboard boom that is each fitted with an end float and 12 transducers. These booms are raised and lowered on Sampson posts located on the forward outboard portion of each hull. The third boom subassembly is a between-hull mechanism fitted with 5 transducers. Two transducers have been installed in each hull. All transducers are spaced at a 1.3 metre interval. The port and starboard booms are stored along the main cabin structure during transit. To deploy, the booms are lifted out of the storage cradles, lowered to water level and swung outward, perpendicular to the ship's hull. The centre boom is rotated into operational position from its normal deck storage position. Hydraulic controls are used in the deployment and recovery of the booms.

Data Acquisition and Processing Systems

A Navitronic Seadig 201 Sweep System was acquired as the data acquisition system. The main components are:

6 MCS	6 Channel Echosounder
1 DPP	Depth Preprocessor
1 HDH	Hydrographic Data Handler
1 Tandberg TDC 3000	Tape Drive
1 PGU	Path Guidance Unit
1 HP 7470	Plotter
1 HP 2563	Printer
1 HP 237	Computer
1 HP 9133H	Disc Drive
1 LSR 1807	Line Scan Recorder

Figure 2 shows a block diagram of the Navitronic Seadig 201 Sweep System. A turn-key HP237 PASCAL software package supplied by Navitronic is used for data acquisition, position computation and line running. The HP237 acts as the interface to the system and provides a status display for the operator to monitor the overall operation of the survey. The system is interfaced to the vessel's autopilot and may be used to automatically steer the vessel along predetermined survey lines. The LSR 1807 generates along-track profiles from each transducer and is used to monitor the operation of the echosounders and for data verification.

Operated in the fastest mode, the sweep system can make 39,600 depth measurements per minute. The Depth Preprocessor selects, in real time, a small

Figure 1 CSS FCG SMITH General Arrangement Diagram.

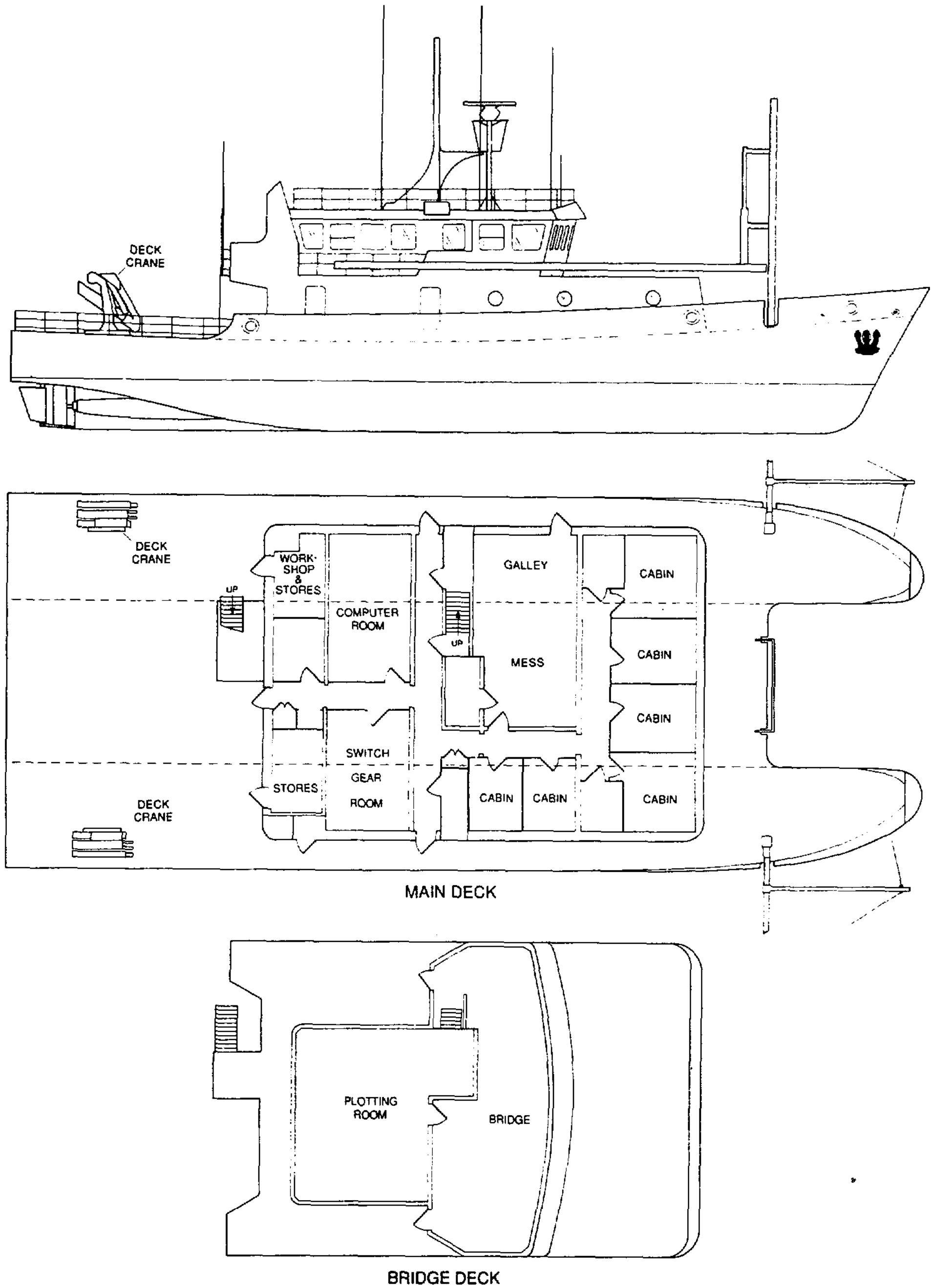
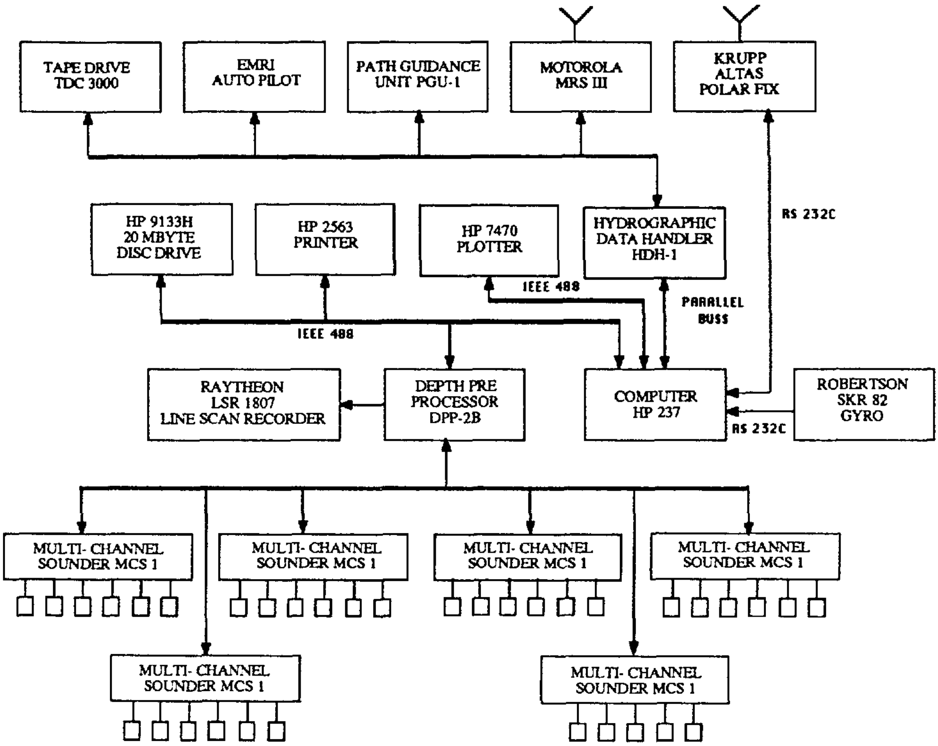


Figure 2 Block Diagram of the Navitronic Seadig 201 Sweep System.



percentage of all the depth measurements made. The selection criteria, which is at the discretion of the operator, is normally set to acquire the shallowest depth occurring within a logging interval. On a typical day up to 500,000 depth measurements are recorded on magnetic tape for subsequent off-line processing.

The CSS FCG SMITH is equipped with a MicroVAX II Computer System with 5 Mbytes of memory and a VMS Operating System. Peripherals include an Altek Digitizer Tablet, HP 7586 Plotter, 3 RD 53 Disc Drives, TK 50 Tape Drive, TSV05 9 Track Tape Drive, TDC 3000 Tape Drive, LA120 Printer, VT240 and 6 VT320 Terminals. A general purpose verification, editing and processing package has been written in FORTRAN for the vessel by CHS staff [Burke, 1988].

Operations

A typical survey project usually requires 1 to 3 days of ship time; however, major surveys such as the Miramichi River in New Brunswick normally take in excess of 3 weeks. Software is available for 3 positioning systems, Motorola Mini-Ranger III, Sercel Syledis and Krupp Atlas Polar Fix. Any 2 may be utilized concurrently using the various integration and filtering options that are available in the data acquisition software package.

Once the ship is in the survey area the booms can be deployed or recovered in 15 to 20 minutes. In most instances a helmsman cons the vessel along predetermined survey lines using the output from the Path Guidance Unit. While the computer can be used to steer the vessel, it has been found that the helmsman can normally do a better job of conning the vessel when the weather and currents are unpredictable. The catamaran hull has proven to be highly manoeuvrable and well suited to working in restricted channels and near docks. On a typical survey, several passes will be made over an area to provide data redundancy which is used in subsequent data processing and verification.

At the end of each day data are transferred to the MicroVax II for overnight batch processing. The next morning results and plots from the previous day's work are available to the Hydrographer-in-Charge. The resulting track, swath coverage and bathymetric plots and accompanying printouts are used to ensure that adequate coverage has been obtained and that the data appear valid. The bathymetric plots are a shoal biased and overplot removed subset of all the logged data. These plots can be manually overlaid with previous plots from the area or the computer files concatenated to produce up to date plots of all data in the project area.

Final editing and verification of the bathymetry has proven to be a very tedious and time consuming process. In critical areas data that are suspect must be carefully examined. Unfortunately, the echosounding system may give an occasional erroneous depth because of fish, aeration, kelp, etc. In order to eliminate erroneous depth data it is necessary to carefully examine the along track profiles and depth printouts from each pass over the area in question. A special program is available to search through all the data and produce a summary printout of all the deep and shallow measurements for a given covering rectangle (size operator selectable) on a pass by pass basis. In order to use this program, the bathymetric plot has to be registered on the digitizer tablet and the operator uses the cursor to identify the suspect depth. The tablet can also be used for deleting erroneous depths and obtaining summary printouts of all sounding attributes-i.e. time, position, transducer number, tide correction, processing status flag, etc. While the initial goal was to be able to process data as fast as the system was able to collect it, experience has shown that 3 to 5 days are normally required for the final processing and verification of the data that are collected during a typical survey day. Even with consideration for transit and setup between projects there has not been sufficient time to complete all the data processing prior to the end of the field season. Consequently, some of the lower priority projects may not get final processing until sometime after the end of the field season.

Summary

The CSS FCG SMITH has completed 3 successful survey seasons and has proven to be well suited for the port and harbor surveys for which she was designed. It is estimated that in excess of 75 million depth measurements have been logged and processed over this period. The major bottleneck that remains to be resolved with respect to the overall operation is the time required to complete the final data processing and verification. A major research and development initiative is planned for the coming year. CHS will investigate the use of more sophisticated software tools aimed at eliminating many of the tedious and time consuming tasks of error detection and verification that are currently carried out in an interactive fashion by a data processor.

References

Burke, R.G. and Forbes, S.R. *Vertical Acoustic Sweep Systems: A 'New Broom in the Closet' for the Canadian Hydrographic Service.* Proceedings of Hydro 84, National Ocean Service Hydrographic Conference, pp. 50-58.

Burke, R.G., Forbes, S.R. and White, K.T. *Processing 'Large' Data Sets from 100% Bottom Coverage 'Shallow' Water Sweep Surveys.* International, Hydrographic Review, Volume 65 No. 2, July 1988, pp 75-89.

THE POSSIBILITIES OF USING REMOTE SENSING/GIS FOR COASTAL RESOURCES MANAGEMENT: THE COASTAL BARRIER RESOURCES ACT OF 1982

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The United States has been in the fore-front of remote sensing technology. However, the use of such technology in the civilian sector of the nation has not been very extensive. This may be attributed to the fact that satellite imagery analysis is still in the experimental stage. Many improvements have been made since the first Landsat system was launched in 1972. Seven satellites later, however, although technological improvements are still being made,designers of remote sensors and image analysis software packages overlook the data needs of some user groups.

Here I will attempt to give very general introduction to satellite imagery and Geographic Information Systems; to discuss a case study of at the federal level in connection with the Coastal Barrier Resources Act; uses of 'multistage sensor' systems and, finally, to present a number of reason why, in my opinion, user groups such as coastal resources managers are failing to make more extensive use of satellite imagery.

I. BENEFITS OF MULTISTAGE SENSING, SATELLITE IMAGERY AND GEOGRAPHICAL INFORMATION SYSTEMS

Multistage sensing is a process involving integration of data from a variety of sensors mounted on different levels and platforms (Dueker, 1987). The data is recorded in a digital format which facilitates its analysis by computers. Satellite imagery, a component of multistage sensing, is attractive for a number of reasons. The first of these is that several images can be obtained from one place in a relatively short time. A satellite orbits the earth rapidly and repeatedly. Depending on the system used, changes can be traced in a time interval as short as three days (SPOT1).

A second advantage of satellite imagery is the large area perspective which it allows the image processor to interpret. For example, in order to choose sampling stations for water quality or sediment transport study areas, a "hierarchy" of data sets can be used (Merry, McKim, Lapotin and Adams, 1988). After satellite images provide a unified image for a large area points of special interest may be selected and then studied more intensely. Choosing an appropriate time period for sampling works much the same way. Consecutive images of a location indicate when and how often changes are likely to occur. Determining the best times for sampling in this manner minimizes costs by reducing the frequency of sampling and the number of sampling stations.

Table 1 gives an overview of some of the satellite capabilities available on the market. In examining Table 1, one needs to understand some basic satellite imagery language. Resolution refers to the size of the smallest object which can be seen or detected by the sensors on the satellite. Band refers to the spectral signature or reflective radiation wavelengths which each sensor can pick up. Each band has a different spectral signature and sensitivity to certain ground features over others ranging from .45 to 2.35 micrometers in the TM Landsat (Short, 1982). Combination of the bands also provide information on ground features, or oceanic features as it may be. Of the satellite systems listed, the French-launched SPOT1, amongst the newest of the commercial satellites has a unique scanning system which provides the best ground resolution information with short repeat intervals. The United States-launched Landsat satellites, equipped with multispectral sensor (MSS) and thematic mapper (TM) capabilities respectively, have not been very successful in identifying landuse. In capturing landcover information however, both systems, especially the thematic mapper have been successful in particular experiments.

The move towards creating geo-referenced data bases which institutions and agencies can share should contribute substantially to the use of multistage sensors. Such data bases are an essential element of the Geographic Information System (GIS), the data management component of multistage sensing systems. GIS is actually array of computer-based systems which provide a wide range of formats and scales for collection, manifestation, and storage of data. The power of a given GIS software package is a function of its ability to convert remote sensing data (raster or grid cell based) for GIS (vector-based) use. Remote sensing data stored in digital format is easily accessed and manipulated by many GIS software packages (Goodenough, 1988). The most significant benefit to be had from using multistage sensor systems with GIS data management component is the increased ease of data retrieval and adjustment (updating or other alterations) which such methods offer.

Table, 1. A few of the satellite sensors with images in market.

SENSORS	**RESOLUTION**	**COMMENTS**
CZCS, Coastal-Zone Color Scanner.	800 meters	6-band mechanical scanner, orbited on October 1978. For chlorophyll concentrations and coastal zone sediment transport (Slater, 1985).
Landsat, NASA,	80 meters	Multispectral Scanner System, 4-bands 18 days repeat coverage.
Landsat, NASA,	30 meters	Thematic Mapper, 7-bands, with 16 days repeat coverage, swath width, 185 kilometers.
OCM, Ocean Color-Monitor, launched by the European Space Agency.	between 200 800 meters	13-band push-broom system proposed. 3 day repeat coverage (Slater, 1985)
SPOT, French,	10 and 20 meters	3-multispectral mode bands and one panchromatic, 60 kilometers swath based on High Resolution Visible imaging (Courtois and Traiset, 1986).

II. THE COASTAL BARRIER RESOURCES ACT

Examination of the Coastal Barrier Resources Act of 1982 (CBRA) provides insights into how multistage sensor systems might be used by a government agency. There are two major reasons why remote sensing and GIS are especially appropriate for use in conjunction with elements of CBRA. For one thing, Barrier island systems are dynamic features. Subject to continuous wave and wind energy, they are in constant flux. Most barrier island systems are large enough to fall within the resolution range of remote sensors. Their size and changing nature make barrier islands a prime candidate for satellite monitoring. The second reason for discussing GIS and remote sensing in the CBRA context has to do with provisions incorporated into the legislation. The Act required preparation of a set of maps which would delineate undeveloped barrier islands. Thus a government agency was mandated by law to produce maps for which remote sensing and GIS would have been ideal. The maps eventually produced, however, were made without these aids. This oversight is indicative of problems, usually political, which have stopped some agencies from making full use of potential of remote sensing in coastal resource management. To illustrate why remote sensing in particular was not more fully utilized in connection with CBRA- ordered mapping, I will be examining the history and selected provisions of the Act as well as the controversy surrounding the proposed maps. I will also touch on the ways in which remote sensing technology might have been incorporated into the CBRA mapping project.

On April 27 and 28 of 1981, Representative Evans introduced CBRA, House Bill 3252, and a day later Senator Chaffee introduced CBRA bill 1018 to the Senate (97th Congress, 1981). Two major objectives stated in S.1018 were: to provide habitat for fish and wildlife and to minimize the federal expenditure which was identified to be the major factor in the development of the barrier islands (DOI Work Group EIS, 1979). Various terms and provision of CBRA engendered debate, but perhaps the most controversial part of the Act was the use of 'undeveloped barrier system's criteria for prohibition of federal assistance. 'Undeveloped barriers' were defined as areas which have "...[f]ew, if any man-made structures (S.1018, 1982)" existing on them. These areas were to be delineated on the maps produced by a Department of the Interior (DOI) Task Force. For a barrier island system to be designated as 'undeveloped' on the maps, CBRA guidelines stated that building density could be less than one structure per five acres (S.1018 sec. 4, 1982).

Not surprisingly, special interest groups such as National Association of Home Builders and the National Association of Realtors (Kuhen, 1984) were unhappy about CBRA's passage. They were particularly concerned about losing monies from a slew of federal programs if their properties showed up on maps designated as 'undeveloped'. The assistance referred to according to S.1018, prohibitions to <u>all</u> assistance not including

> "...[d]eposit account insurance for customers of banks, savings and loan associations, credit unions and similar institutions; the purchase of mortgages or loans by the Government National Association or the Federal Home Loan Mortgage Corporation; and assistance for environmental studies, planning and assessment that are required by such laws on the National Environmental Protection Act or the Clean Water Act sec. 10 of the River and Harbors Act of 1899. The legislation would not restrict Federal Funds to be used on undeveloped barrier systems for programs

entirely unrelated to development or such systems that already have some sort of protection structure or plans on them (S.1018, 1982)"

Even though the Act, overall, with little opposition from government agencies or Congress. Even DOI Secretary James Watt, who had received the National Association of Realtors' American Eagle Award for his commitment to private property rights, supported the bill (Kuhen, 1984). As soon as opponents of CBRA realized its popularity with Congress and the certainty of its passage, they directed their efforts to keeping their individual parcels of property from the 'undeveloped' designation.

Secretary Watt was designated to supervise the making of the maps used for the purposes of CBRA. He then delegated the authority to the assistant secretary of Fish and Wildlife to carry-out the work. A Coastal Barriers Task Force was created, headed by Richard David, to study the 1.4 million acres of coastal barriers (S.1018 sec.1 , 1982) and submit maps produced. According to the Act, 47% of the 1.4 million acres was undeveloped but protected therefore only 13% which was undeveloped and unprotected would have to fall under the jurisdiction of CBRA (S.1018 accommodating report, May 25, 1982).

The Act was vague on the subject of 'undeveloped barriers'. What constituted a 'structure'? On August 16, 1982 the Task Force stated in its report that for one structure per five acre to qualify for the developed designation, there had to be accompanying infrastructure,

"...Vehicle access to each building or lot site and reasonable availability of a water supply, waste water disposal system, electric source to each lot or building site...The presence on a coastal barrier of a single road or even a through highway plus associated electric transmission and water and sewer lines in this highway corridor does not constitute the necessary full complement of infrastructure necessary to support development"(Gordon, 1984)

'Phased development' had to be taken into consideration as well. 'Phased development' referred to as yet 'structure-less' parcels of land which, nonetheless, already represented massive investments. In its report the Task Force stated

"...Existence of intensive private capitalization on-the-ground within a coastal barrier area is the most significant indication of its development status" (Gordon, 1984)

Accommodating special interest let the Task Force to prefer older mapping methods to remote sensing/GIS techniques. It was easier to use the already well established methods of gathering map data, so that justification of methods at least was not necessary. As a result, for the most part the Task Force relied on U.S. Geological Survey topographic maps with overlays of recent aerial photographs when available.

The final set of maps produced, over 1000 (Federal Registry, March 4, '85), included 186 Coastal Barrier Units covering 656 miles of shoreline (Kuhen, 84). Before the final agreement there were 64 set of maps which created a great deal of debate in both the Senate and the House. The legislators accepted 23 of the Senate maps, 27 of the House maps, 3 of the DOI maps, and 4 maps with alterations on their boundaries. Seven of the maps presented were discarded entirely (Kuhen, 84). While satellite imagery was not used in producing the first set of CBRA maps, it still offers a useful tool for maintaining accurate information on the barrier island systems under CBRA jurisdiction. By law, the maps used in CBRA related efforts must be updated every 5 years. This potentially a mammoth undertaking, and traditional modes of collecting and managing such data will not be efficient compared to 'multistage sensing' data collection. The process of reviewing, ground-truthing, and revising U.S.G.S topographic maps, for example,is time consuming and inefficient. The present DOI maps, translated into digital formate for GIS purposes, would provide a good baseline data level for future CBRA mapping activities.

To review, CBRA mapping needs might have been most efficiently addressed if multistage sensors and GIS were used from the start. Opportunities still exist, however, to integrate these technologies into CBRA mapping efforts since CBRA maps must be updated every 5 years. In fact, multistage sensor system offer some important advantages when used in combination with more traditional methods of landuse analysis. Changes in barrier island systems can be evaluated more efficiently when areal photography interpretation and ground-truthing are used selectively on the basis of information compiled from satellite imagery/GIS. Database updating and adjustment are also facilitated. Earlier hesitance to use remote sensing and GIS for CBRA mapping can be attributed to one, the newness of these technologies; and second political pressure to produce maps with already accepted methods, and more flexible for exemption purposes.

In the absence of political maneuvering, the major draw back to more widespread application of satellite remote sensing is the short tradition of its use and the highly experimental stage of the technology. Traditional modes of mapping and acquiring data are deeply ingrained in the bureaucracy of agencies and institutions which conduct such activities. Technical personnel are comfortable using aerial photographs to locate and classify landcover, and managers are comfortable filing reports with results tabulated from well-established forms of data. In the coastal resources management sector satellite remote sensing may also be under-utilized because of limited use of this technologies by academics. Research is taking place but mostly in areas unrelated to coastal resource management sectors (Merideth and Sacks, 1986).

In conclusion, satellite remote sensing and GIS hold considerable potential for coastal resource management. For this potential to be realized, however, government institutions and other user groups must make a combined, serious commitment to using these technologies setting standards for their use, and authorizing further research.

Lack of further usage of multistage sensors may be attributed to difficulty of replacing traditional modes of information gathering and processing with the new available technology. It will be up to the agency involved to make a decision on switching from traditional modes of data collection and management to the new forms available. At first such switches can be costly but they will prove to be most cost effective and efficient in the long run.

References

-Coastal Barrier Resources Act, 16 U.S.C., S.1018. 97th Congress session, also REPORT to accompany S.1018 submitted by Mr. Chafee, from the Committee on Environment an Public Works, May, 26, 1982.

-Courtois, M.,M.Traizet, "The Spot Satellites:From SPOT1 to SPOT4" *Geocarto International*, Vol.3, pp.4-14, 1986

-Dueker, K.J., "Multipurpose Land Information Systems: Technical, Economic, Institutional Issues." *Photogrammetric Engineering and Remote Sensing*, Vol.53, No.10, October, 1987

-Federal Register, Department of the Interior, Part II, Vol.50, No.42, Notices, March 4, 1985

-Goodenough, D.G. "Thematic Mapper and SPOT Integration with a Geographic Information System" *Photogrammetric Engineering and Remote Sensing*, Vol.54, No.2, February 1988, pp. 167-176

-Gordon, W.R., "The Coastal Barrier Resources Act of 1982: An Assessment of Legislative Intent, Process, and Exemption Alternatives." *Coastal Zone Management Journal*, Vol. 12, No.2/3, 1984

-Kuhen, R.R., "The Coastal Barrier Resources Act and the Expenditures Limitations Approach to Natural Resources Conservation: Wave of the Future or Island Unto Itself?" *Ecology Law Quarterly*, Vol.4, 1984

-Lindgren, D.T., Landuse Planning and Remote Sensing. Martinus Nijhoff Publishers Boston, 1985

-Merideth Jr., R.W. and A.B. Sacks, "Education in Environmental Remote Sensing: A Bibliography and Characterization of Doctoral Dissertations" *Photogrammetric Engineering and Remote Sensing*, Vol.52, No.3, March 1986, pp.349-365.

-Merry, C.J, L.H. McKim, N.LaPotin and J.R.Adams, "Use of SPOT HRV Data in the Corps of Engineers Dredging Program", *Photogrammetric Engineering and Remote Sensing*, Vol. 54, No.9, pp. 1295-1299, September 1988

-Short, N.M., The Landsat Tutorial Work-Book, Basics of Satellite Remote Sensing. NASA, Scientific and Technical Information Branch, Washington, D.C., 1982

-Slater, P.N., "Survey of Multispectral Imaging Systems for Earth Observations" *Remote Sensing of Environment*, Vol. 17, pp. 85-102, 1985

COASTAL AREA MANAGEMENT COURSE CONTENT ANALYSIS[1]

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Paper presented at The Coastal Society's Annual Meeting
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Coastal Area Management Education

Coastal Area Management (CAM) and Environmental Impact Assessment and Analysis (EISA) are two legislative initiatives which have been widely copied by both developed and developing countries in recent years.

Within the past five years the federal government has recognized the importance of CAM especially in developing countries, many of which are experiencing very rapid demographic development along their coasts. For example, the United States Agency for International Development (USAID) has funded two CAM programs, one based in Manilla, Philippines and one carried out at the University of Rhode Island (USAID/URI CAM Project).

While the latter is initially targeting three countries (Sri Lanka, Thailand, and Ecuador), an underlying assumption is that the CAM efforts in the three nations will serve as prototypes for other coastal countries in their region.

Several project objectives were written into the final agreement among USAID, URI, and each of the participating countries. Two objectives have direct relevance to this paper. One is institution building and one is related to education and training, specifically the development and transfer of CAM experience to professionals in the three countries.

This paper is a preliminary report on an ongoing effort to develop a CAM/EIS training module intended for short-term courses and workshops to be offered in the host country.

We decided that the design of a CAM/EIS training module should be based on a survey incorporating topical and conceptual content of CAM courses offered in the U.S. and abroad. We did not want to duplicate the work of others but build upon it when possible.

Coastal Area Management is a new academic study area and, as a result, educational programs are in various stages of planning and implementation at several academic institutions both here and abroad. Programs have been stimulated by employment opportunities within both the private and public sectors. Given this demand and interest in offering CAM training, what are the components which should be covered by a course? What should be the design of each component? Are there at the present time some common themes among those who teach in this area?

It is not our intent to suggest conformity among the professionals teaching CAM courses; rather, it is our intention to stimulate a discussion among coastal management professionals.

Survey Analysis

The surveys were sent to colleagues here and abroad who have or are offering courses in Coastal Area Management, Coastal Resources Management, Coastal Zone Policy and Law. Most of our contributors were known to either one or both of us. A few of our foreign colleagues were identified in conversations with our domestic CAM colleagues. Most of the contacts were made by phone, and all but two we contacted agreed to share their course outlines with us.

The survey identified 21 CM courses. To date we have received 20 responses which consisted of course outlines, statement of objectives, and other supporting documents. Following receipt of this material, fifty-six different topics were identified and categorized in one of seven different groups (Table 1). The seven classes were based on a functional classification derived by the authors and may not upon further analysis reflect existing course structures.

The nineteen courses deal with various aspects of coastal management, coastal resources, coastal uses, and coastal policy. Professionals teaching and researching this field vary from planners, geographers, physical, biological, political scientists and lawyers. It is probably inevitable that each discipline would address the topics covered under the broad rubric of coastal management and policy from their own particular disciplinary perspective.

Considerable value judgment, of course, is involved in this classification scheme. Some instructors tend to cover many topics under a given category which may not necessarily be discerned from the outline. To this extent this approach is flawed; yet we believe that this initial tabulation may be valuable insofar as it tends to demonstrate the breadth of the subject matter. Of course, we are aware of the potential fallacies and the subsequent interpretation should not be viewed as a definitive study but as an initial step in identifying the composition of CAM courses.

Table 1
FUNCTIONAL CLASSIFICATION OF TOPICS INCLUDED IN CAM COURSES

ENVIRONMENTAL TYPES AND PROCESSES
- Islands including Barrier Islands and Beaches
- Coral and Mangroves
- Mammals
- Nearshore Marine Processes
- Soils
- Wetlands

USES
- Commercial Fisheries/Aquaculture
- Marine Recreationa and Tourism
- Marine Transportation
- Mining Other than Oil and Gas
- Navy
- Ocean Energy
- Oil and Gas
- Ports
- Residential Development
- Urban Development

ENVIRONMENTAL IMPACTS
- Erosion
- Hazardous Waste
- Landuse Changes
- Marine Pollution

PHYSICAL SCIENCE AND ENGINEERING PROCEDURES AND RESPONSES
- Climatology and Geomorphology
- Estuarine and Bay Analysis
- Hazards
- Physical and Biological Science
- Shore Protection and Engineering
- Subsidence

AREA MANAGEMENT
- Access
- Coastal Regions
- Coastal and Marine Sanctuaries
- Special Area Management

LEGAL PROCEDURES
- Environmental and Coastal Regulations
- Environmental Legislation not including CZMA
- Federal Coastal Management Laws/Regulations
- Governance
- Law
- Policy Methods
- Public Trust Doctrine

MANAGEMENT AND PLANNING PROCEDURES
- CAM in Developing Countries
- Conservation Philosophy
- Case Studies
- Cultural Resource Analysis
- Conflict Resolution
- Environmental Amenity/Perception/VRM
- Environmental Impact Assessment
- Environmental Resource Planning
- GIS/Remote Sensing
- Industrial Siting
- Inventories
- Models and/or Games
- Management Methods
- Planning Techniques
- Public Participation
- Research Policy
- Resource Economics
- Shore Protection Management
- Visual Resource Management
- Social Analysis

Findings

Table 2 is a summary of the topics and courses currently offered either here or abroad. Columns represent courses and rows represent topics included in the submitted course outlines.

The number of topics included in the twenty courses vary from a low of 10 to a high of 27 (Mean 16.3, Standard Deviation 5.7). The specific range probably is a surrogate measure of the course emphasis and orientation; for instance, a coastal policy course is more likely to emphasize the legal aspect of the Coastal Zone Management Act and the regulations related to the CZM programs which have met with federal approval.

The average number a given topic is included in the twenty courses appear in Table 3 and vary from one to fourteen (Mean 5.8, Std. Dev. 3.0). The larger the number of times a given topic is adopted across the nineteen courses, the greater the degree of topical congruence. The "congruence factor" expressed as a percentage of maximum agreement[2] varies from 5% to 80% (Table 3). For example, Table 3 shows that 14 of the 20 courses (totalling 70%) included fishing as a topic, while visual resource management and ocean energy were included in only one course each (accounting for 5.0 %).

Implications

New areas of research usually evolve from one or more of the established disciplines. For example, ecology contains elements of biology, hydrology, and geography. Similarly, regional scientists have borrowed research methods and approaches from economics, planning, physical and human geography. Coastal management has evolved from the physical and biological sciences including several of the social sciences. The various approaches which have been taken especially during the field's initial years, reflect the background of the professionals working in the area. Applying these concepts to coastal management, one would indeed expect a wide range of topics and the approach taken in the courses being offered. We believe there are two related factors which have hindered the development of a more cohesive educational program. Both factors are related to research and research funding.

Table 2

COURSE TOPICS INCLUDED IN C.A.M. COURSES
NUMBER REFER TO COURSE TITLES LISTED BELOW

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Class Project/Paper	x		x	x	x		x	x	x		x		x	x	x	x	x	x	x	x
Final Exam.	x		x	x	x		x			x					x	x		x		x
ENVIRONMENTAL TYPES AND PROCESSES																				
Barrier Isl./Isl.			x	x	x		x		x		x			x		x				x
Coral & Mangroves		x		x		x							x							
Mammals	x	x	x						x									x		
Nearsh. Mar. Proc.	x			x	x	x			x					x						
Soils				x	x	x						x								
Wetlands	x		x			x	x		x				x	x		x		x		x
USES																				
Com. Fish./Aqua.	x	x	x		x	x	x		x					x	x	x	x	x	x	x
Mar. Rec & Tour.		x		x		x					x					x			x	
Mar. Trsp.			x		x					x							x		x	
Mining (Other)	x	x			x	x			x					x	x		x		x	
Navy		x	x														x		x	
Oil and Gas	x	x			x	x			x	x			x	x	x	x		x	x	
Ocean Energy																			x	
Ports	x			x	x					x	x		x			x	x		x	
Resid. Develop.	x			x	x	x				x					x					
Urban	x		x	x	x															
ENVIRONMENTAL IMPACTS																				
Erosion			x	x	x	x														x
Hazardous Waste													x				x			
Landuse Change				x	x	x							x							
Marine Pollution		x		x	x	x			x	x			x	x			x		x	x
PHYSICAL SCIENCE AND ENGINEERING PROCEDURES AND RESPONSES																				
Climat./Geomorph.	x					x	x							x	x					
Estuarine Anal.	x			x	x											x	x	x		x
Hazards			x	x	x	x									x			x		
Phys./Biol. Sci.		x		x	x	x	x		x	x		x		x			x		x	
Shore Prot./Eng.	x					x	x		x					x	x	x		x		x
Subsidence			x						x											

COURSE TOPICS INCLUDED IN C.A.M. COURSES
NUMBER REFER TO COURSES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AREA MANAGEMENT PROCEDURES																				
Access	x						x					x						x		
Coastal Region	x		x	x	x	x		x				x	x						x	x
Coast./Mar. Sanct.	x					x										x				x
Spec. Area Mgt.	x									x										x
LEGAL PROCEDURES																				
Env. & Coast. Regs.											x	x	x		x		x			
Env. Legislation											x				x					
Fed. CM Laws/Reg.	x			x			x	x		x	x	x				x	x	x		
Governance				x			x			x	x	x			x	x	x	x	x	
Law	x			x	x		x	x				x				x		x	x	
Policy Methods	x		x	x				x			x	x			x		x	x	x	
Public Trust Doc	x				x													x	x	
MANAGEMENT AND PLANNING PROCEDURES																				
CAM Devel. Count.				x	x	x		x					x				x			
Case Studies															x	x	x		x	x
Conserv. Phil.						x				x	x	x	x							
Cult. Reso. Anal.						x				x									x	
Conflict Resol.	x			x	x			x						x	x			x	x	
Env. Amenit./Percept.				x	x							x						x		
Env. Imp. Assess.								x		x							x			
Env. Reso. Plan.												x	x							x
GIS, Remote Sens.	x					x		x										x	x	x
Industrial Siting							x		x											
Inventories	x			x		x														
Models/Games					x							x				x				x
Mgmt. Methods	x			x	x			x				x	x	x	x			x		
Planning Tech.				x		x	x				x		x					x		x
Public Particip.		x		x								x	x						x	
Research Policy													x				x	x	x	
Res. Econ.				x								x						x	x	
Shore Prot. Mgmt.	x				x			x					x					x		x
Social Analysis														x					x	
	25	10	12	27	25	24	12	10	12	10	10	16	16	13	14	13	17	21	22	16

The development of any new discipline is first and foremost based on the research addressing problems concerning the subject. The development of Marine Affairs and more specifically Coastal Management as an emerging discipline was stimulated by a demand for solutions to practical applied problems associated with allocating resources in the coastal and nearshore marine environment. There is little doubt that the field has been influenced, if not directed, by the research undertaken to address problems identified with this environment. Courses addressing coastal management and policy have relied almost exclusively on readings and supplementary text since no textbook in CAM and coastal policy has yet been written.[3]

In the context of coastal management, the overwhelming amount of recent research has been funded through two efforts -- NOAA's Sea Grant Program and NOAA's program for implementing CZMA. The two programs have several commonalities which have affected the type of research (and thus the knowledge related to coastal management). First, both programs, while largely federally funded, are primarily managed on the state level. Second, a significant portion of the research stemming from either program has been applied research. Third, nearly all the research funded through the state's coastal management program has addressed state problems at the local level, a criticism which can also be levied against the Sea Grant supported research.

Table 3

AVERAGE NUMBER A TOPIC IS INCLUDED WITHIN EACH OF THE 20 CAM COURSES IDENTIFIED

	Number of Courses	Congruence Factor
Class Project	12	80.0
Final Exam./Present.	8	45.0
Commercial Fish./Aquaculture	14	70.0
Oil and Gas	11	55.0
Physical and Biological Sciences	11	55.0
Coastal Regions	10	50.0
Federal Coastal Management Law and Regulations	10	50.0
Governance	10	50.0
Marine Pollution	10	50.0
Policy Methods	10	50.7
Wetlands	10	50.0
Islands and Barrier Islands and Beaches	9	45.0
Management Methods	9	45.0
Mining Other than Oil and Gas	9	45.0
Ports	9	50.0
Shore Protection and Engineering	9	45.0
Conflict Resolution	8	40.0
Law	8	40.0
Estuarine Analysis	7	33.3
Planning Techniques	7	33.3
CAM in Developing Countries	6	30.0
GIS and/or Remote Sensing	6	30.0
Hazards	6	30.0
Marine Recreation and Tourism	6	30.0
Nearshore Marine Processes	6	30.0
Residential Development	6	30.0

AVERAGE NUMBER A TOPIC IS INCLUDED WITHIN EACH OF THE 20 CAM COURSES IDENTIFIED

	Number of Courses	Congruence Factor
Climatology/Geomorphology	5	25.0
Conservation Philosophy	5	25.0
Env. & Coast. Regs	5	25.0
Mammals	5	25.0
Marine Transportation not including Ports	5	25.0
Resource Economics	5	25.0
Access	4	20.0
Coastal and/or Marine Sanctuaries	4	20.0
Coral and Mangroves	4	20.0
Erosion	4	20.0
Landuse Change	4	20.0
Models/Games	4	20.0
Public Participation	4	20.0
Soils	4	20.0
Urban	4	20.0
Shore Protection Management	5	25.0
Case Studies	5	25.0
Navy	4	20.0
Public Trust Doctrine	4	20.0
Cultural Resource Analysis	3	15.0
Environmental Impact Assessment	3	15.0
Environmental Resource Planning	3	15.0
Inventories	3	15.0
Research Policy	3	15.0
Special Area Management	3	15.0
Environmental Legislation not including CZMA	2	10.0
Hazardous Waste	2	10.0
Industrial Siting	2	10.0
Social Analysis	2	10.0
Subsidence	2	10.0
Visual Resource Management	1	5.0
Ocean Energy	1	5.0

The result has been a vast amount of site specific (ideographic) research. So far, very few efforts have been made to summarize the considerable number of site specific studies which have been conducted over the years. In short, many research dollars and man hours have been spent re-inventing the wheel.

The applied research direction has had an important educational impact. The few efforts to summarize the studies which had addressed similar type problems have slowed the process of coastal educational convergence. The extensive "fugitive" research (most of it ideographic) which has been published in reports, proceedings and publications has done little to enhance the development of a reasonably cohesive coastal management and policy text(s) which would enhance the cohesiveness of the discipline.

What are the implications for the future progression of coastal management and policy courses? Two related developments may occur. First, it is quite possible that an increase in the number of courses will take place; however, it is difficult to speculate on the directions which this development may take. Some courses may emphasize the legal and policy issues related to coastal and nearshore resources; others may emphasize the management of the social processes occurring within the coastal region, while still other courses may concentrate on the bio- physical processes.

The second development concerns the content of the courses. As Coastal Management becomes better established as an educational endeavor, it is expected that the number of topics included within each course category will decrease. It is further anticipated that a corresponding development or a greater convergence of topics will take place.

Together, this evolution suggests both a broadening of the topic(s) of coastal management and policy as well as greater specificity within the newer courses. The evolution suggests a maturation of coastal management both as a professional practice and as a topic which is in the process of creating its own research approach and methodology.

FOOTNOTES

1 Support for this research was obtained from the USAID-URI Coastal Area Management Project

2 $$\frac{C = 0 \times 100}{N}$$

where:
C = congruence factor
O = observed frequency of topics included among the nineteen courses;
N = Maximum number each topic could be included in all courses

3 The evolution of textual material generally proceeds from a series of articles addressing topics to a reader or edited papers. Assuming the subject matter continues to evolve, one or more texts will eventually be written.

AN INSIGHT TO INVERSE CONDEMNATION: THE NEW HORIZON THROUGH THE SPIRIT OF LUTHERGLEN AND THE NOLLAN LINK

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THE NEW HORIZON OF INVERSE CONDEMNATION

The Coastal Zone has become the intersection for a collision of public environmental and private interest. At this intersection we will find tremendous insights as experienced that will hopefully bring to the new horizon, i.e. a new balanced approach to the conflicting legal interests in the zone.

A historical perspective

Since 1985, the Court has been echoing, by way of a growing crescendo, its prologue to the Evangelical Lutheran Church and Nollan cases. These cases were Keystone Bituminous Coal Association v. Pennsylvania 107 S. Ct. 1232 (1987)., MacDonald, Sommer & Frates v. Yolo Co., No. 84-2015, 107 S. Ct. 22, 92 L. Ed. 2d 773 (1986); Williamson County Regional Planning Commission v. Hamilton Bank, 473 U.S. 172 105 S. Ct. 3108, 87 L. Ed. 2d 126, 53 U.S.L.W. 4969 (1985) and U.S. v. Riverside Bayview Homes, Inc. 474 U.S. 121, 106 S. Ct. 455, 474 U.S. 121, 23 ERC 1561, 88 L. Ed. 2d 419, 54 U.S.L.W. 4027 (1985).

This series of cases echoes an old tune, but to a new and modern rhythm. The message was, has been and continues to be clear. The public interest in protecting our nation's natural and environmental land, and water resources is high. This is paramount under the political power. It is this great public trust that has been and will continue to be consistently upheld to the subordination of individual property rights. Cavaet: In a nation that colonists and immigrants gravitated to because of their desire to own a piece of its soil under the protection of law, it is only natural that this Country's highest Court should accomplish what is fundamental to the American way of life. It has upheld respect for the forefather's foundation of protection of these individual property rights, i.e. the Fifth Amendment. The true spirit has returned to the phrase "private property (shall not) be taken for public use, without just compensation". Since 1776 this provision has served as a hallmark of protection to offset the power of the government to take property for public purpose by way of condemnation. Inverse condemnation is nothing more than the forcing of a Governmental Body to respect the Fifth Amendment, exercise its power of eminent domain directly, rather than attempting to take property rights' indirectly by strict regulation.

The new horizon

Inverse condemnation sits securely between the valid exercise of the police power and the valid direct exercise of the power of eminent domain. Remedially the Evangelical Lutheran Church and Nollan cases clearly mandate that compensation must be paid to the property owner whether the regulation is temporary or permanent. The stripping of private property rights through important valid regulation of sensitive environmental areas has been balanced—this is the new horizon. A horizon that required insight as the state of the law and respecting its application in practice.

The wisdom of Justice Holmes expressed in 9122 in Pennsylvania Coal Co. v. Mahon, 260 U.S. 393 is alive and the essence of the new horizon of land-use cases. Holmes stated:

> "***[t]he general rule at least is, that while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking." Id at 415, emphasis supplied, cited by the Court at 11.
>
> "A strong public desire to improve public conditions is not enough to warrant achieving the desire by a shorter cut than the constitutional way of paying for the change". At 416.

The issue is not one of the validity of the regulation. That is assumed and accepted. If the validity is in question, the remedial perspective is totally different. Inverse condemnation conceded the validity of the regulation in question. A regulatory taking generates a remedy mandated by the Fifth Amendment of the Constitution, i.e. just compensation to the property owner. This point is missed by many of the older cases which tend to confuse and mix the police power and eminent domain. The Fifth Amendment in no way attempted to prohibit the valid exercise of eminent domain in the taking of private property for public purpose. It provided the offsetting protection to the property owner; the fair market value of that which was taken. This is in essence the goal of inverse condemnation.

The merits of the "taking" were not at all involved in the Evangelical Lutheran Church case. They were assumed and accepted. The regulation in question was one of the Los Angeles County Flood Control District. It prohibited the "construction, reconstruction, place or in large any building or structure, any portion of which is or will be, located within the outer boundaries of the interim flood protection area locate in Mill Creek Canyon***". The provision, indeed is not unusual in this contemporary decade. It is similar to much of the flood control legislation that pervades the country. It is similar to much of the wetland, critical and sensitive area regulatory body of law that exists today. Thus, this article seeks to provide insight respecting the law and guidance regarding just compensation in a valid regulatory setting.

The spirit of Lutherglen: the facts

In 1957 the Church purchased land and constructed a camp ground known as "Lutherglen". It was a retreat and recreation center for handicapped children. The land was located alongside the banks of Mill Creek Canyon. This land is a natural drainage channel for the watershed district. In 1978, a tremendous flood destroyed the structures at Lutherglen. In 1979 the Los Angeles County Flood Control District passed a typical interim flood protection area ordinance. It prohibited the construction or reconstruction of any building or structure in the area designated. This included the property of Lutherglen. Lutherglen immediately challenged the regulation. One of the grounds was an unartful and "criptic" count of inverse condemnation. The trial court granted a motion to strike this allegation. It based its ruling on Agins vs. Tiburon, 24 Cal. 3d. 266, 598 P.2d 25 (Aff'd. on other grounds, 447 U.S. 255 ( ). In Agins the California Supreme Court held that a property owner has no claim for inverse condemnation which is based upon a "regulatory challenge or taking". It is stated that compensation is not required until the challenged regulation has been held to have gone "too far" in an action for Declaratory Relief or Writ of Mandamus. In addition the Government thereafter had to continue the regulation in effect. The Trial Court reasoned that since the church alleged a regulatory taking and sought only damages, i.e. no attempt to invalidate the ordinance, the allegation had to be dismissed. The California Court of Appeals affirmed. The essence of this decision framed the key issue in the case, i.e. Is monetary relief under the Fifth and Fourteenth Amendments appropriate for "temporary" regulatory takings?

The issue and holding

The novel or landmark nature of this case is not the establishing of a meritorious "regulatory taking" case or criteria. That was not involved. That holding has been addressed on numerous occasions by the court. The holding for which the First Lutheran Church case shall always be known is that there is a monetary remedy for "temporary" regulatory takings. Under the Agins case compensation was not required until the regulation in question had been deemed excessive and the regulation continued.

Chief Justice Rehnquist framed the issue and holding as follows:

> "In this case the California Court of Appeal held that a landowner claims that his property has been "taken" by a land-use regulation may not recover damages for the time before it is finally determined that the regulation constitutes a "taking" of its property. We disagree, and conclude that in these circumstances the Fifth and Fourteenth Amendments to the United States Constitution would require compensation for that period."

Thus, temporary just compensation must now be paid by Governmental Bodies for what is typically known as a temporary regulatory taking. This is the essence of the Evangelical Lutheran Church case. Thus a well intended, well founded and perfectly valid declaration prohibiting construction in a wetland area, tidal or fresh water, may very well require the responsible Government Agency or Body to pay compensatory damages for the period in question. The typical moratorium regulation and old cases are also drawn into question.

The linkage of Nollan: the facts

The Nollan's own ocean front property in Ventura County, north of Los Angeles. In 1982 they decided to demolish their existing home to put up a large home. The California Coastal Commission, similar to the many State Environmental Protection Agencies, certain regulations which restricted construction in the Coastal area. An eight foot concrete seawalls separates the beach portion of the property form the building portion of the lot. The California Coastal Commission permitted the construction on the property in question upon condition that the Nollan's provided increased access for the public along the beach in front of their proposed home. The Commission had found "that the new house would increase blockage of the view of the ocean, thus contributing to the development of 'a wall' of residential structures" that would prevent the public "psychologically*** from realizing a stretch of coastline exists nearby that they would have every right to visit". The Commission found that "the new house also increased private use of the shorefront". As a result the Commission could properly and did "require the Nollan's to offset that burden by providing additional lateral access to the public beaches in the form of an easement across their property". It should be noted that the Commission had similarly conditioned 43 other development permits. Access to the beach provision are common throughout the coastal area.

The issue and holding

The United States Supreme Court first addressed the issue of similarity between an outright taking of an easement and the conditioning of a construction permit on the granting of an access easement. It stated:

> "To say that the appropriation of a public easement across a landowner's premises does not constitute the taking of a property interest but rather, *** is to use words in a manner that deprives them of all their ordinary meaning. Indeed, one of the principle uses of the eminent domain power is to assure that the government be able to require conveyance of just such interest, so long as it pays for them."

It made no difference to the Court that the public had the right of way along any navigable waterway in California. This public trust is common in many coastal states.

The Court framed its first issue and concluded:

> "Given, then, that requiring uncompensation conveyance of the easement would violate the Fourteenth Amendment, the question becomes whether requiring it to be conveyed as a condition for issuing a land use permit alters the outcome. We have long recognized that land use regulation does not effect a taking if it substantially advance(s) legitimate state interests and documents not den(y) an owner economically viable use of his land."

In both the Lutheran Church and Nollan cases inverse condemnation occurred. In both cases compensation was required. In Lutherglen compensation was required even for "temporary" damages, in that the regulation was subsequently amended. In Nollan compensation was required for the taking of property rights in mandating public access to the ocean.

The issue in the Nollan case was also a narrow one. However, as in the Lutherglen case the Opinion supported the strong protection of private property rights. In Nollan the narrow issue was that of taking private property to provide "increased access for the public along the public beaches". The bottom line of both cases is that government must be prepared to pay property owners fair market value of property rights that are taken. This is not intended to diminish the laudatory public purposes of its regulations nor the nexus of the particular restriction or condition.

Riparian Lands—Linkage

The Court in Nollan highlighted the various "sticks in the bundle of rights" which we know as property rights. (Slip Op. p. 5). The hurdle of property rights of owners of riparian lands are indeed different. However, each hurdle will be valued for what it is.

This holding addresses the important subject matter of "linkage". For decades, planning bodies have been linking to approvals various conditions involving instructing of on-site and off-site improvements, posting of various sums of money for public interest type of facilities and the like. The line of cases that have dealt with this subject matter, prior to Nollan, have addressed the issue of validity of these conditions. Many have been upheld, many have been struck. However, Nollan is different. Nollan tells us that when it is determined that the link or condition is valid there still may be remedy for the property owner as against the governmental body in question. That remedy is inverse condemnation if the linkage has effectuated a "taking".

New Jersey Cases

Inverse condemnation has been no stranger to the New Jersey Courts. From 1963 to date there has been a series of important cases. Morris County Land Improvement Co. v. Parsippany-Troy Hills Township 40 NJ 539 (1963) was one of the earliest decisions. A zoning ordinance constituted a "taking" where it contained highly restrictive use of swamp land. Lomarch Corp. v. Englewood 51 NJ 108 (1968) but followed and is also cited. As an Inverse Condemnation Authority. Schiavone Construction Co. v. Hackensack Meadowlands Development Commission 98 NJ 258, 486 A2d 330 cited (1985), Dallmeyer v. Lacey Township Board of Adjustment 529 A.2d 1063 (1987) should also be cited. Recently and presently before the Appellate Division is the case of Catanzaro v. Hackensack Meadowlands Development Commission No. LOH7586-85TW.

Four-tier analysis

In the MacDonald case the supreme court, in a closely split decision, addressed the ripeness issue. There the plaintiff property owner brought an action for inverse condemnation. In 1975 the plaintiff had submitted a subdivision map to defendant Yolo County Planning Commission. It proposed to divide farmland into 159 single family and multi-family residents. The proposal was rejected and the County Board of Supervisors affirmed the rejection on various grounds. The grounds specifically addressed in the U.S. Supreme Court decision were the inadequacy of public street access, sewer services, water supplies and police protection. The property was therefore limited to ranch and farm dwellings and agricultural storage facilities.

The plaintiff filed an action is the California Superior Court alleging that the denial appropriated the total economic use of the property to provide for the public a "open space buffer". The court dismissed the complaint holding that its allegations were insufficient. The California Court of Appeal affirmed the Lower Court decision and the Supreme Court of California denied a Petition for Hearing. The plaintiff then perfected an appeal to the United States Supreme Court. The matter was taken "because of the importance of the question whether a monetary relief in inverse condemnation is constitutionally required in appropriate cases involving regulatory takings". The majority decision of the United States Supreme Court did not address the merits of the case, deciding that the issue was not ripe.

The primary issue addressed in the MacDonald case by the Supreme Court is that of "ripeness" in inverse condemnation actions. The Court pointed out that a plaintiff "must establish that the regulation has in substance 'taken' his property" (Id. at). In this context the Court stated that it is "an essential prerequisite to its assertion is a final and authoritative determination of the type and intensity of development legally permitted on the subject property" (Slip Op. p. 7). The court proceed to examine and emphasize that the factors as it relates to this inquiry were "***such as the economic impact of the regulation, its interference with reasonable investment-backed expections, and the character of the governmental action***–that have particular significance". (Slip Op. p. 8). The Court quoted Kaiser Aetna v. United State, 44 U.S. 164, at 175 (1979) and also referred to Penn Central Transportation Co. v. New York City 438 U.S. 104, 124, 1978 verifying Ad Hoc factual inquiries. The Court then proceeded to cite United States v. Central Eureka Mining Co., 357 U.S. 155, 168 (1985) for the proposition that this particular inquiry turns "upon the particular circumstances of each case". It is at this point that the court made reference to the recent case of Williamson Planning Comm'n. v. Hamilton Bank, 473 U.S.---, n. 11 (1985) Id. at p. 352.

The Court, in this regard, stated:

> "Until a property owner has 'obtained a final decision regarding the application of the zoning ordinance and subdivision regulations to its property', it is impossible to tell whether the land retains any reasonable beneficial use or whether (existing) exception interest have been destroyed". Id.

The Court then proceeded to set forth the important essence of where the law is today.

> ***a court cannot determine whether a municipality has failed to provide 'just compensation' until it knows what, if any Body intends to provide, quoting Williamson. ***The Local Agencies charged with administering regulations governing property development are singularly flexible institutions; what they take with the one hand they may give back with the other. (Slip Op. p. 9)

The Court ultimately got to the essence of the inverse condemnation cases:

> "Whether the inquiry asks if a regulation has "gone too far" or whether it seeks to determine if proffered compensation is 'just', no answer is possible until a court knows what use, if any, may be made of the affected property." (Slip Op. p. 9-10)

The Court then stated in a footnote:

"a property owner is of course not required to resort to piece-meal litigation or otherwise unfair procedures in order to obtain this determination. See Williamson Planning Commission v. Hamilton Bank, 473 U.S. at (Slip Op. p. 4-5); Stevens, J. Concurring in Judgment; United States v. Dickinson, 331 U.S. 745, 749 (1974). (Slip Op. p. 10n.)

The Court reviewed all of the various condemnation cases that had proceeded the McDonald case. All uniformly mandate the compensation should be granted when the governing body would not permit "beneficial use" of the property. The Court's decision was very clear that in this recent McDonald holding:

"***the holdings of both Courts below leave open the possibility that some development will be permitted, and thus again leave us in doubt regarding the antecedent question whether appellants property has been taken". (emphasis supplied) (Slip Op. p. 11-12)

Two other recent United States Supreme Court cases have addressed the ripeness issue, i.e. Williamson v. Riverside Bayview Homes. In Williamson, MacDonald and Riverside Bayview Homes the ripeness issue was the ultimate one upon which these cases were resolved. In Williamson the United States Supreme Court did not get to the merits because the issue was not ripe. There the Hamilton Bank was the successor in interest of the developers of a track of land in Williamson County, Tennessee. In 1973, the County Planning Commission changed its zoning ordinance to permit cluster development and approved such a development on a tract in question. Plot lines for 469 parcels wee shown on the preliminary subdivision plot. There was a total of 736 units allowed on the parcel. AFter dedicating some 245 acres to the County for open space, the development project began in various sections. Approvals had been granted over a course of time. In the Williamson case the span of time was between 1973 and 1979. During this 6 year period, actions were taken by the developer in reliance upon the approvals.

There came a time in 1977 that the public body changed its position. It did this by way of zoning regulations. Yet, the Commission continued its policy of applying the 1973 ordinance in granting subsequent development approvals on the parcel in question until 1980. At that time the Commission then disapproved a plot for the tract because it failed to comply with the requirements of the 1977 ordinance. Hamilton brought suit against the Commission in Federal District Court. The Trial Court granted the Commission's motion for directed verdict on the equal protection and substantive due process claims. A jury returned a verdict in Hamilton's favor, finding in answers to special interrogatories, that Hamilton had been denied economically viable use of its property in violation of the just compensation clause of the United States Constitution and further stopping the Commission from requiring compliance with the 1977 regulations as opposed to the 1973 regulations. Three-Hundred Fifty Thousand Dollars was awarded in damages for the temporary taking of the property measured from the time its plat was approved until trial. The Trial Court issued a permanent injunction requiring application of the 1973 regulations and granted the planning commission's request for summary judgment notwithstanding the verdict on the taking issue. That Court stated:

Any damages which plaintiff suffered resulted from an attempt by the local government to apply regulations in a manner impermissible under State law. Because the State law itself prevents continued application of those regulations there can be no taking property prohibited by the just compensation clause of the Fifth Amendment. The U.S. District Court of Appeals reversed the District Court on the judgment notwithstanding the verdict and reinstated the $350,000 award. That Court stated that Justice Brennan's dissent in the case of San Diego that just compensation must be paid for a temporary regulatory taking.

The United States Supreme Court in the case of U.S. vs. Riverside Bayview Homes, Inc., 106 Supreme Ct. 455 (1985) dealt with the issue of the jurisdiction of the U.S. Corps of Engineers as to a potential wetland tract. Ultimately the Court found that the Corps had jurisdiction. The Court, however, then proceeded to find that "the mere assertion of regulatory jurisdiction by a governmental body does not constitute a regulatory taking". Id. at p. 459.

The Court in Riverside reiterated the warnings, however, then Agins dictate that a taking will occur if either no "legitimate state interest" is advanced or the property owner is denied "economically viable use of his property". It concluded:

> "Only when a permit is denied and the effect of the denial is to prevent 'economically viable' use of the property in question can it be said that a taking has occurred." Id.

Most of the U.S. Courts, Circuit and District, found the ripeness issue as a convenient vehicle to postpone the inevitable. In U.S. vs. Ciampitti, 583, F.Suppl. 483 (1984) the U.S. Army Corps of Engineers enjoined the development of a substantial tract of land in Cape May County. The tract had been under development for decades with a public sewerage system (treatment of which was funded federally, and had been substantially developed previously). Once the Court found the property to be wetlands and under the jurisdiction of the Corps of Engineers, the property owner urged that their actions constituted a "regulatory taking". The Court stated:

> "The defendants argue in a conclusory fashion that the 1907 Grant vests absolute property rights in the grantee and his successors. If defendants mean to argue by this that the Government may not "take" the property, their argument is premature. As defendant Ciampitti has not applied for a permit and, consequently, has not been refused a permit, and no taking without just compensation is presently cognizable: there has been no determination that the property may not be put in the uses desire. Avoyelles Sportsmans League, Inc. vs. Marsh, 715 F.2d 897, 927 (5th Cir. 1983)." at p. 495-496.

The ripeness issue as one still reoccurring as a hurdle for the prospective condemnee. As for the involuntary condemnor, it provides little comfort, yet an opportunity to avoid inverse condemnation of reasonable permissive use in the permit process.

A practical guideline for lawyers

Out of the Spirit of Lutherglen, and the linkage of Nollan and the Yolo County, Williamson and Riverside cases, the new horizon of inverse condemnation provides the governmental and private practitioner with certain clear guidelines.

1. Governmental Agencies must be extremely cautious prior to exercising

their legislative or executive regulatory prohibitionary type of power, whether it be on a permanent or on a moratorium basis. There is no solace or peace in the fact that the police power may permit such an exercise. The line of cases upholding moratoriums, for example, as a valid exercise of police power, in no way are protected from the wrath of the Lutherglen remedy. That wrath is "we acknowledge a moratorium to be valid, however, you may have to pay just compensation to the property owner for such an option". The police power cases cannot (although they often do) be confused with the concepts of eminent domain. The private practitioner has a potential additional remedy available.

2. The determination of whether or not there is a taking will primarily be a factual one. It is one that will function in ranges. It will vary from case to case utilizing, presently, the reasonable economic real estate value standard. Diminution of value is not enough. The elimination of reasonable economic value is the criteria.

3. The taking issue interlines with the ripeness issue. It may very well be that prior to determine whether or not there is a taking the ripeness issue must be determined. Governmental Agencies should provide a process wherein some economic use of the property is permitted, regardless of the extent. This is government's major armor against inverse condemnation. The giving of concessions and compromise will indeed be a large money saver. The administrative process is much more geared to hearings addressed to such deviations than the judicial system. The private practitioner, on the other hand, must make sure that every available potential for development of the property for any economic use under the system provided is pursued.

4. When the issue ripe and the taking has been found the value issues then surface into reality. The methodologies to be utilized in this respect will be primarily the well accepted real estate appraisal and economic theory approaches. This is the subject of another article. Expert testimony and support will be at the essence of this determination. The valuation determination also will be a factual one.

The Spirit of Lutherglen and the linkage of Nollan, long in rising, has risen. The new horizon of inverse condemnation is here to provide the balance between needed protection of sensitive environmental land areas and private property rights.

PRESERVATION OF THE CAPE HATTERAS LIGHTHOUSE: THE NATIONAL RESEARCH COUNCIL STUDY

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ABSTRACT

The world-famous Cape Hatteras Lighthouse, symbol of the Outer Banks of North Carolina, is faced with eventual destruction due to shoreline retreat. Stop-gap measures have provided a temporary reprieve, but the lighthouse now sits on an unstable bulge in the shoreline, only 160 feet from mean high water. A major hurricane could undermine its pine log footings, which extend only seven feet below grade, possibly leading to collapse of the structure.

The National Research Council Committee on Options to Preserve Cape Hatteras Lighthouse was formed in July, 1987 under contract between the NRC and the National Park Service to advise the latter on the relative feasibility of various methods of providing long-term protection to the structure. The Committee recommends against construction of a seawell/revetment (earlier approved by NPS) and other *in situ* efforts to resist shoreline retreat. Instead, the Committee recommends relocation of the lighthouse in one piece, together with its accessory buildings, to a site 500 feet landward of its present site. Lifting beams would be left in place (concealed by sand) to facilitate further relocation when necessary.

HISTORICAL BACKGROUND

The Cape Hatteras Lighthouse, at 208 feet the tallest and best-known brick lighthouse in the United States, faces destruction due to coastal erosion. The present lighthouse was constructed in 1870, replacing an earlier masonry tower built near the present site in 1803. The principal mission of this lighthouse and its predecessor was to protect shipping from the dangerous Diamond Shoals that extend 13 miles seaward—the "Graveyard of the Atlantic"—where at least 600 ships have been lost. At the time of its construction, the lighthouse was approximately 1500 feet from the water's edge. By the 1930s, this distance had diminished to about 150 feet due to shoreline retreat (MTMA, 1980).

Today it remains precariously at about this same distance due to a series of stopgap and emergency measures taken over the past 50 years to protect the lighthouse and an adjacent Coast Guard facility. These have included: (1) an artificial dune constructed along Hatteras Island by the Civilian Conservation Corps in the 1930s; (2) a now-deteriorating field of three groins abreast and north of the tower, constructed in 1969-70 and repaired in 1975; (3) the nourishment of the beach north of the lighthouse with 200,000 cubic yards of sand in 1971 and with 1,250,000 cubic yards of sand in 1973; (4) nylon sandbags installed in the late 1960s and again in 1980; (5) a 150-foot landward extension of the southern groin in the form of sheetpiles, constructed in 1980 to prevent flanking; and (6) artificial seagrass installed in 1982 and again in 1986. Some of these measures, notably the groin field, have temporarily reduced the rate of retreat of the shoreline and may even have promoted accretion of the beach for a short time. However, they do not provide long-term protection to the lighthouse, and presently require costly repairs and redesign.

The apparent stabilization of the shoreline near the lighthouse since the 1930s is misleading. Since 1870, the shoreline has receded approximately 1600 feet (Corps of Engineers, 1985), except for a small bulge at the lighthouse. Research by coastal geomorphologists over the past two decades has yielded a better understanding of the migratory nature of coastal barriers, including the influence of gradual sea-level rise (Kaufman and Pilkey, 1983). The shore in front of the Cape Hatteras Lighthouse is steep and narrow. This relatively steep gradient suggests that the shoreline is poised to return to equilibrium through sudden recession in the event of a major storm or series of storms (Everts, 1987).

Storm surges of about 9 feet above normal high tide have approximately a 1 percent probability of occurrence each year (MTMA, 1980, p. 38, based on National Weather Service data). The lighthouse, having a foundation that extends only about 80 inches below grade (Lisle, 1985), might be damaged or conceivably destroyed if such a surge overwhelmed the degraded groin field and sandbag defenses. A series of lesser storm surges might also produce disastrous effects.

Since 1980, the NPS has considered diverse measures for protecting the lighthouse and associated buildings—two keepers' dwellings and an oilhouse. One proposal, approved by the NPS in 1982 and funded by Congress in 1987, would involve construction of an octagonal revetment and seawall eventually to encircle the tower, reaching a height of 23 feet above sea level (Corps of Engineers, 1985). Alternative proposals considered by the NPS have involved relocation of the lighthouse—either in one piece or in segments. Other options include rehabilitation and expansion of the groin field (with or without a partial revetment); sinking of ships offshore to create an artificial reef; construction of near shore breakwaters together with rehabilitation of the groin field; installation of artificial seagrass; ongoing beach nourishment; replacement with a new lighthouse; and taking no action.

RELEVANT PUBLIC POLICIES

The selection of a preferred option to preserve the lighthouse involves evaluation of a complex set of variables, including coastal geomorphology and ecology, engineering and economic feasibility, and diverse public policies. The Committee's interim and final reports (NRC, 1987a; 1988) address issues in each of these areas. This paper will discuss only the public policy implications. The relevant policies are diverse and in some cases mutually inconsistent. Issues of federalism, state sovereignty, and municipal home rule abound. With these caveats in mind, the following are the policies identified by the Committee:

Protection of Navigation. Ironically, the original purpose of the lighthouse—to prevent shipwrecks on Diamond Shoals by providing a warning light—is of little significance to the question of how the lighthouse should be preserved. The present light, which is visible on a clear night to a distance of 26 miles, is supplemented by a beacon on a "Texas tower" 13 miles seaward at the outer edge of Diamond Shoals. Modern shipping relies chiefly upon LORAN and other electronic navigational systems. Therefore, the present navigational value of the lighthouse chiefly applies to small craft.

NPS Mandate. The National Park Service Organic Act charges the National Park Service (NPS) with a dual mandate: "... to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C., Sec. 1).

In the case of Cape Hatteras Lighthouse, this mandate applies equally to the Light itself as a historical artifact of great importance, and to the beach, dunes, wetlands and other natural resources of the National Seashore. Options which compromise the latter in the interest of preserving the Light are thus presumably disfavored. An option which would preserve the Light while minimizing human alteration of natural processes (e.g., relocation) would presumably be preferred.

The Committee believes that the "no action" option, which will lead to loss of the lighthouse due to shoreline erosion, would be incompatible with the NPS Organic Act, and also with the Cape Hatteras National Seashore Recreation Area Act of 1937.

Protection of Historic Structures. The National Historic Preservation Act of 1966 and Executive Order 11593 declare a national policy favoring the preservation of historic structures. The Cape Hatteras Lighthouse is on the national and state registers of historic landmarks. It eminently qualifies as a structure worthy of preservation.

Preservation of a historic structure through its relocation is permitted under NPS policies, provided that: no historic structure shall be moved if its structural integrity or preservation would be adversely affected thereby. Further, "Every effort shall be made to reestablish its historic orientation, immediate setting, and general relationship to its environment" (NPS, 1978, p. v-18).

Coastal Barrier Recession. The Coastal Barrier Resources Act of 1982 (CBRA) expressed congressional recognition of the migratory and dynamic nature of coastal barriers. The Act prohibits certain federal expenditures that would encourage development of designated undeveloped, nonpublic coastal barriers. The Cape Hatteras site, being federally owned, is not directly covered by the CBRA. Nevertheless, the Act reflects a broader national policy that public investment decisions should recognize the dynamic nature of coastal barriers. Selection of an option or options to preserve the Cape Hatteras Lighthouse should serve as a precedent and example for public response to erosion of coastal barriers elsewhere.

In general, the NPS favors "letting nature take its course" with respect to coastal erosion affecting Park Service facilities. However, it does distinguish between "natural zones" and "historic zones." In the latter, the NPS management policy provides that "control measures, if necessary, will be predicted on through studies taking into account the major velocity of the shoreline processes, the threat to the cultural resource, the significance of the cultural resource, and alternatives,...and how control measures [sic] would impair resources and processes in natural zones" (NPS, 1978, p. IV-22). It is further stated that "where erosion control is required by law, or where present developments must be protected to achieve park management objectives, the Service will employ "the most natural appearing and effective method feasible" (ibid., p. IV-23).

Flood Hazard Mitigation. The National Flood Insurance Act of 1968, as amended, articulates a national policy that flood losses, both coastal and riverine, should be reduced through adjustment of human activities in flood hazard areas, in place of engineering projects to control flooding. Executive Order 11988 (1977) further provides that the federal government will avoid investing in identified flood hazard areas where reasonable alternatives exist.

Enhancement of Recreation and Tourism. The Cape Hatteras Lighthouse is a focal point of the Cape Hatteras National Seashore and the Outer Banks. Even though the lighthouse is not currently open to the public, about 140,000 people visited the lighthouse site in FY 1986 (out of an estimated 1.6 million visitors to the entire National Seashore). Such tourism provides an important contribution to the economy of the area. Maintenance of continuity of the beach along Hatteras Island in its currently unobstructed state is important to the recreational function of the National Seashore.

Public Education. The Cape Hatteras Lighthouse and its site are an important resource for public education. Topics that may be fruitfully interpreted at the site include: (1) the maritime and settlement history of the Outer Banks; (2) the physical and ecological nature of coastal barriers; (3) the effects of hurricanes and coastal storm hazards; and (4) the design and operation of this lighthouse and of lighthouses generally in the United States.

Wetlands Protection. The Federal Clean Water Act, Section 404, reflects a broad policy favoring the protection of tidal and freshwater wetlands and establishes a permit program to regulate dredging or filling of wetlands under the joint administration of the Corps of Engineers and the U. S. Environmental Protection Agency. In general, disturbance of natural wetlands is disfavored if a suitable non-wetland site is available. Executive Order 11990 (1977) similarly prohibits federal actions that disturb wetlands if alternative sites are available.

Federal Consistency with State Law. The Federal Coastal Zone Management Act of 1972 declared "...a national interest in the effective management, beneficial use, protection, and development of the coastal zone" (16 U. S. C., Sec. 1451) and further noted that "Important ecological, cultural, historic, and aesthetic values in the coastal zone...are being irretrievably damaged or lost" (16 U. S. C., Sec. 1451). To implement national coastal policy, the Act facilitated development of state coastal zone management programs under federal guidelines and partial funding and provided that "Each federal agency conducting or supporting activities directly affecting the coastal zone shall conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with approved state management programs" (16 U. S. C., Sec. 1456(c) (1).

THE PREFERRED OPTION: RELOCATION

The relocation option was deemed by the NRC Committee to best satisfy the foregoing policies, as well as pertinent engineering, scientific, and other criteria. The basic concept proposed by the Committee involves moving the entire lighthouse structure in one piece to a new site approximately 500 feet landward of its present site. The new site now lies at the far side of an area devoted to parking lots and lawn and thus would involve little disturbance of natural habitat. In contrast to a more distant site proposed by Move the Lighthouse, Inc. (1987), the 500-foot site would retain a sense of proximity to the beach and would remain in essentially the same position with respect to the local community of Buxton, North Carolina. In contrast to the revetment/seawall option, which NPS has earlier selected, the spatial relationship of the lighthouse to its accessory buildings would be retained. The cost of moving the entire complex to the 500-foot site would be approximately $4.6 million, as compared with an estimated construction cost of $5.72 million for the seawall revetment (Corps of Engineers, 1985).

A critical consideration in this proposal is that a relocation of 500 feet might only "buy" two or three decades of protection from further shoreline retreat. To achieve a 100-year probability of protection would entail a move of much greater distance, cost, andenvironmental impact. The Committee instead envisions a "stepwise relocation" which could be repeated as the need arises. The steel lifting beams which would be inserted through the granite base of the lighthouse would be inserted through the granite base of the lighthouse would be left in place and concealed from view by sand and vegetation. When necessary, a further relocation to a new site would thus be facilitated. The chief cost would be the laying of a temporary concrete track on which to roll the lighthouse to its new destination.

This principle of "stepwise relocation" or a "portable lighthouse" reflects the likelihood of further landward retreat of the shoreline at Cape Hatteras. While the rate of retreat is uncertain due to varying estimates of sea level rise over the coming century (NRC, 1987b). further erosion is highly probable. The concept is offered as an appropriate precedent for public and private response to coastal erosion elsewhere.

REFERENCES

Everts, C. H. 1987. "Continental Shelf Evolution in Response to Rise in Sea Level." In Nummedal, O. Pilkey, and J. Howard, *Sea Level Rise and Coastal Evolution*. Special Publication 41. Society of Paleontologists and Minerologists.

Kaufman, W. and O. H. Pilkey, Jr. 1983. *The Beaches are Moving The Drowning of America's Shoreline*. Durham, N. C.: Duke University Press.

Lisle, L. D. 1985. "Foundation of the Cape Hatteras Lighthouse *Shore and Beach*," April 1985: 29-31.

Move The Lighthouse Committee. 1987. *Move It or Lose It*. Cary, N. C.: Move The Lighthouse Committee.

MTMA Associates. 1980. *Study and Report: Cape Hatteras Lighthouse*. Denver: National Park Service.

National Park Service. 1978. *Preserving Our Heritage: Management Policies of the National Park Service*. Washington: NPS.

National Research Council. 1987a. *Options for Preserving the Cape Hatteras Lighthouse: Interim Report*. Washington: National Academy Press.

----------. 1987b. *Responding to Changes in Sea Level*. Washington: National Academy Press.

----------. 1988. *Saving Cape Hatteras Lighthouse from the Sea: Options and Policy Implications*. Washington: National Academy Press.

U. S. Army Corps of Engineers. 1985. *Seawell and Revetment Design for Long-Term Protection of Cape Hatteras Lighthouse, North Carolina*. Wilmington, N.C.: U.S. Army Corps of Engineers.